FINAL REPORT

ON THE

PROPOSED IMPROVEMENT

OF THE

AJMER WATER SUPPLY,

DRAWN UP BY

S. O. HEINEMANN, Esq.,

Municipal Engineer,

1908.

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CONTENTS.

Report on the proposed improvement of the Ajmer Water supply.

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1. The necessity of the scheme.

Ajmer is situated in a horse shoe valley at an elevation of 1600 feet above the sea. The out flow from the valley to the south eventually finds its way to the Indian Ocean, while that from the country beyond the Northern hills passes to the Bay of Bengal.

Ajmer may therefore be said to form a portion of the great Watershed of India. This being the case it is obvious, that practically no water can flow into Ajmer there being only a small catchment area above the valley.

In this small catchment area two lakes have been formed, the Anasagar and the Foysagar.

On these lakes Ajmer has in the main depended for water. The only other source of supply being the small natural lake at Budha Puskar where a pumping plant was installed by the R.-M. Railway, in 1899-1900.

The Anasagar water is only used for gardens and Dhobi Ghats.

All these sources of supply are very precarious the catchments being small and the rainfall most precarious. Appendix G. gives the annual rainfall and storage of the Foysagar lake.

The loss of water by evaporation in the dry climate of Ajmer is on an average 5 feet per annum and the amount of water lost by evaporation is a very serious consideration.

With the increase of the population of Ajmer the consumption of water has risen from 99-94 Million Gallons per annum in 1897-98 to 257-66 Million Gallons in 07-08 and it is only with the greatest difficulty that these increasing demands can be met even in year of plenty.

In 1907 the lack of water had become acute and Mr. Goodwin, Loco. Superintendent, Rajputana-Malwa Railway strongly advised the Removal of the Rajputana-Malwa Railway Workshops from Ajmer.

Although this proposal would have entailed an expenditure on the part of the Railway of a sum of between 50 to 100 Lacs of Rupees, in the face of the constant recurring scarcity of water which on each occasion was becoming more acute, the Home Board,

were prepared to sanction the scheme, if no adequate supply of water in Ajmer could be found.

The removal of the Workshops from Ajmer would have been an incalculable loss to the place.

In these circumstances every effort was made to find a certain supply of good water.

In April M. Vrendenburg of the Geological Survey of India visited Ajmer and reported on the possibilities of various sources of supply (*Vide* his report Appendix A).

In May Mr. A. E. Silk Sanitary Engineer of Bengal visited Ajmer and made various suggestions and recommendations (*Vide* his report Appendix B.)

By the 25th July the positions of affairs had become most critical as no water had been received in the Foysagar and Anasagar, and the total amount of water available for supply was reported by the Executive Engineer, Ajmer Provincial Division to be not more than sufficient for two months. On the 18th August 1907, 5·45 inches of rain fell and the Foysagar overflowed and Ajmer was saved the horrors of a water famine.

Although this timely and unexpected fall of rain saved the situation for the time being, there always remains the fear that on another occasion such good fortune may not happen.

The present water supply is totally unfit for potable purposes, and is often so dirty that even washing in the water becomes unpleasant. The majority of the people in city obtain all their water for drinking and cooking from the various wells in and round Ajmer. These have also been declared unfit for drinking, but the water appears clean, which is something.

For this water I hear they have to pay as much as *one anna per Ghurra.*

The reasons for the present scheme summarized are :—

1. The precarious nature of the present supply.
2. The bad quality of the present supply.
3. The fact that if no adequate supply is forthcoming the Railway Workshops will be moved.
4. The terrible loss that this movement would cause Ajmer.

The possible sources from which an adequate supply could be obtained, were found to be either the Sarsuti River Valley or the Sagarmati River Valley. The main features of the latter are commented on in my report on the tests carried out during the past hot weather (*Vide* Appendix D.) 2. The possible sources of supply.

The Sarsuti Valley lies beyond Budha Pushkar and is a wide cultivated valley with a steep barrier of hills on the West.

On the Eastern side it is also enclosed by hills until just South of Budha Pushkar, beyond this point the rocky hills disappear below accumulations of driven sand which form the Eastern boundary of the valley.

Borings put down in this valley along the river bed show the rock substratum at a very even level but no great depth of water.

A spring with artesian conditions was found near Galti, but both Mr Vrendenburg and Mr. Silk were of the opinion that no safe supply could be obtained from this point, owing to the very small catchment this spring could have.

The result of the investigations in this valley go to show that there is water in considerable quantities in it but not so much as in the Sagarmati Valley. The nearest point to Ajmer from which a safe supply could be obtained is near the village of Naud.

This point has practically no gain in distance over the proposed site of the water works in the Sagarmati Valley, and all water would have to be pumped over the Pushkar Pass, this and the fact that all materials and stores would also have to be carted over this Pass would make the cost of working much heavier than in the Sagarmati Valley, where the Railway is only about 5 miles from the site of the works.

Full particulars of the tests carried out in the Sagarmati Valley will be found in Appendix D.

Estimated quantity of Water available.

The estimated minimum quantity of water available has been given by Mr. A. E. Silk (*vide* para. 2 of his report appendix C.) as 1,300 Million gallons per annum or over two years supply at the maximum rate of 1,600,000 gallons per diem.

Looking at the well tests in Appendix D. it will be seen that when the test was started at the end of May the water level in the trial well No. 37 was 7·64 ft.

In the section of the bore holes which accompanies that report, the water level was 8·00 ft. This water level was recorded in January so the total fall in the water level from January to May was *only 0·36 feet, not-withstanding that heavy cultivation* was going on in the valley and quantities of water were being pumped out during well sinking in April and May.

From this it appears that there must be a considerable flow of subsoil water into the valley.

Again looking at these tests it is found that the lowest level of the water in the well before pumping commenced (at 7 A. M.) was 6·97′ or a fall of 0·67′. A good deal of irrigation was going on from the neighbouring cultivators wells at the same time, and this was also a drain on the water of the valley.

Taking all these figures into account, and also the fact that, it is said that even during the worst famines the cultivators wells in this valley have never failed, there seems no doubt that an ample supply of water is obtainable from the Sagarmati valley.

In addition to this the natural formation of the valley just west of the site of the water works makes it possible for this amount to be materially increased if necessary at a later date, in the following manner.

Just west of the site the rock substratum of the valley rises in some parts to ground surface, and all across to within a few feet of the ground.

If a concrete or masonry wall were built along this ridge to ground level it would prevent any subsoil water passing away from the valley and thus raise the subsoil water level.

Again should this accumulation of water required further augmentation an earthen bund a few feet in height thrown across the valley along the alignment of the concrete wall, would prevent the surface water flowing past when the Sagarmati River comes down. The usual flood depth is between 3, and 4 and the duration of the floods seldom exceeds a few hours. The water so held up would perculate into the sandy soil of the valley and be stored under-ground for future consumption. There would therefore be no loss by evaporation.

However both these proposals are only put forward, to show how at a future time the supply can be increased, and not for immediate consideration as there is at present sufficient water available for all requirements.

The quantity of water delivered to Ajmer on an average of the past 3 years from the Foysagar and Budha Pushkar was 240·66 million gallons per annum or 660·000 gallons per day. 4. Present Supply & allotment.

The allotment of this supply was :—

	Gallons
City, or standpost supply	396,203
Railway	190,073
Mayo College	20,169
Merwara Battalion	7,623
Private Consumers	55,932

The quantity of 396,203 gallons supplied to the City may be taken as used by the inhabitants of the City proper only as the Suburbs are not yet supplied with a Standpost supply.

The population in the City proper in 1901 was 52,000 therefore this supply amounts to 7·66 gallons per head but at least 22,000 people obtained no supply at all although paying equal taxes.

5. Proposed supply

Detailed reasons for the following allotment are given in my report on the estimate (Appendix E.)

The city or stand post supply is at the rate of 10 gallons per head per diem.

	Gallons.
City	1,000,000
Railway	395,000
Private Consumers	100,000
Mayo College	35,000
Merwara Battalion	15,000
Jail	3,000
Government College	5,000
Railway General Offices	8,000
Balance for unforeseen requirements ...	39,000
Grand Total ...	16,00,000

6. Estimate cost of the scheme

The Estimate (Appendix E.) has been divided into the following sub-heads.

A. Wells.

B/1 Steam pump House.

B/2 Oil Engine pump House.

C. Rising Main.

D. Service reservoir.

E. Distribution.

There is a slight difference of Rs. 3,300 in the total expenditure in favour of a Steam plant, but as the figures for the Engine and plant are necessarily only rough estimates in the absence of tenders it may be taken that the cost of either plant will be about equal.

The estimate is further subdivided into works necessary at once and works which will be required later, as the demand for water increases. As explained in the detailed report on the estimate (Appendix E.)

The total cost of the scheme amounts to Rs. 1,053,621, of this amount Rs. 862,860 are required in the first year Rs. 93,164 in the second year. Rs. 32,977 in the third year. The remaining amounts will be distributed over the next 30 years.

The expenditure that has to be met therefore within 3 years is Rs. 982,001.

Taking the averages of the last 10 years.

7. The State of the Municipal Finances.

The annual income of the Municipality has been Rs. 197,806, and the annual expenditure Rs. 184,043.

The average incidence of the Octroi taxation Rs. 1-4-9 per head of population per annum.

The average excess of receipts over expenditure is Rs. 13,763 per annum.

At the present time there are two loans outstanding :—

1.	Rs.	218,000.
2.	"	20,000.
Total ...	Rs.	238,000.

1. Will be paid off by 30-4-29.
2. " " " 12-3-18.

The annual payments in respect of these loans are :—

1. Rs. 13,184-0-0.
2. " 1,462-3-6.

The Municipality are now proposing to reorganize their sanitation and have applied for a loan of Rs. 50,000 to carry out some very necessary works and further propose to increase their annual expenditure under this head by about Rs. 6,000, per annum.

The annual payments necessary to liquidate this loan will be Rs. 3,679, per annum.

This amount together with the proposed extra annual expenditure of Rs. 6,000, comes to Rs. 9,679, per annum which if taken from the average annual balance of Rs. 13,763, leaves only Rs. 4,084, as the probable average cash balance in future years, with the present forms of taxation.

From the above statement it is at once obvious that except for this small balance of Rs. 4,084, the Municipal funds at present can not provide for the interest and maintenance charges of the new scheme without increased taxtion.

8. Present forms of taxation.

There is only one tax collected by the Municipality namely Octroi.

This tax falls uniformly on all, irrespective of where they live or what is done for them by the Municipality. In this way the inhabitants of the suburbs have been paying equal taxes with those living in the city although they have had no water, poor lighting etc.

Taking the state of affairs in the Municipalities of Allahabad, Delhi and Agra one finds the following taxes levied :—

Allahabad, Octroi, House tax, Water tax with an incidence of taxation of Rs. 2-1-3 per head.

Delhi, Octroi, House tax with an incidence of Rs. 2-1-6, per head.

Agra, Octroi, water tax with an incidence of Rs. 2-1-4.

In two of these Municipalities there is a water tax levied and the incidence of taxation over Rs. 2, per head in all.

The actual incidence of the water tax in Allahabad and Agra, and the House tax in Delhi is :—

Allahabad	0	8	2
Delhi	0	3	8
Agra	0	5	3

The inhabitants of these three towns may be said to be better off, and can therefore afford a higher incidence of taxation, than those in Ajmer of whom a considerable number are workmen in the Rajputana Malwa Railway Shops. Notwithstanding this it is questionable if a tax having an incidence of even 0-8-0 would cause inconvenience, bringing the total incidence of taxation up to Rs. 1-12-9. With the advent of pure drinking water laid on to the city and suburbs, the better class, who now obtain their water from wells, often some distance from their houses, would be saved the cost of carrying the water. The poorer classes who now cannot afford to do this and drink the impure water now delivered in the stand posts would benefit by better health and when it is taken into consideration that the majority of these are daily paid labourers it will be seen that any thing which improves their health improves their income. Taking this incidence of 0-8-0 and taking that the average labourer gets 0-4-0 per diem pay, and has a family of 6 persons dependent on him, the tax will be Rs. 3-0-0 per annum, which will be met if he is able to work only 12 days more.

If this tax is called a water tax it can only be applied to water works but if it is called a house tax it can be applied to any work.

It would seem better therefore to call it a House Tax so that any balance may be utilized for the general improvement of Ajmer.

The fairest way of levying the tax would be that it should be paid by all house owners, whose houses lie within 600 feet of a water pipe line. 9. Income which will be derived from the new tax.

All persons having private connections will be charged as before by meter, but might be given the first 3,000 gallons per month free, in view of their paying this tax.

The income from the tax would amount to approximately Rs. 35,000 per annum.

The maintenance charges, will at first amount to about Rs. 20,000 annum, and those of the present water works to Rs. 4,000 say in all Rs. 25,000 per annum. 10. Estimated annual maintenance charges.

This will leave out of the amount realized by the new tax only Rs. 10,000 per annum to pay off the annual instalment required to liquidate the loans, which it will be necessary to raise.

Exclusive of the amount realized by the sale of water to the Railway, the estimated income from the sale of water to private consumers is Rs. 12,000 bringing up the total available to pay off the loans to Rs. 22,000 per annum.

(The Railway have been left out for reasons given later.)

The payments for a loan of 3 lacs rupees amount to Rs. 21,574. 11. Amount the Municipality can afford to borrow.

Therefore all the Municipality can afford to borrow for this scheme, is Rs. 300,000.

The Railway have asked for 395,000 gallons per diem in the new scheme, but up to now have used on an average only about 200,000 gallons per diem for which they pay 0-5-0 per 1,000, or Rs. 22,812 per annum. If they were allowed to take this quantity of water from the Foysagar free of charge, it would mean a saving to them of the amount Rs. 22,812 per annum, which capitalized at 6 per cent. = Rs. 380,000 say Rs. 400,000. 12. Proposals to meet the difficiency.

If they should require water pumped for their use they might be allowed to have it at cost price provided they gave a further contribution of say Rs. 100,000 or Rs. 5,00,000 in all.

The sum is not a big item when it is considered that should his scheme fall through it will cost them nearly 100 lacs to move the Railway workshops.

This then only leaves a difficiency of Rs. 1,89,000 to complete the schemes and this might be given by Government as a grant-in-aid.

Ajmer has considerable claims on Government as the centre of administration of Ajmer-Merwara.

Government might also be asked to pay for the preliminary investigations of this scheme (details of the cost of which are given in Appendix H.) as it is understood has been done in other provinces.

Such Government grants for works of utility have been given elsewhere, notably in Agra Rs. 15,000 was contributed by Government towards the cost of a new water main estimated at only Rs. 22,000 during the financial year 1906-1907, and 2 grants of Rs. $1\frac{1}{4}$ lacs each are about to be given for the improvement of Allahabad.

AJMER: S. O. HEINEMANN,

Dated the 11th July 1908. *Municipal Engineer, Ajmer.*

APPENDIX A.

Report on the Possibility of Improving the water-supply of Ajmer.

By Mr. E. W. Vrendenburg, Geological Survey of India.

(1) I arrived at Ajmer on the 5th of April, and reported myself, on arrival to the Commissioner of Ajmer-Merwara, Major C. H. Pritchard, to whom I feel deeply indebted for the efficient assistance which he constantly gave me in investigating the question of the water-supply of the city of Ajmer.

(2) On the morning of the 6th, the Executive Engineer, Pandit Sham Nath, Rai Bahadur, accompanied me over the upper valley of the Sagarmati, from the Foysagar to the Bisla tank. In the afternoon I attended a meeting of the General Committee at the Town Hall. On the 7th in the morning, Mr. Waddington, Chairman of the Municipality, very kindly showed me the valley of the Sagarmati below Ajmer as far as Dorai. In the afternoon I was accompanied by Tahsildar to the valley of Madarpura and to Kiranipura. On the 8th, I visited the valley of the Sagarmati below Dorai up to Bhaonta. On the 9th I visited the Budha Pushkar lake and the valley of the Sarusti from Galti to Ganahera. On the 10th I visited the Kair tank. During these three days I was accompanied by Pandit Sham Nath who has gone to great pains to show me all the places of interest, and furnish me with all the information that could be of use in this investigation.

PHYSICAL AND GEOLOGICAL FEATURES.

(3) The structure of the neighbourhood of Ajmer, is that which characterises the Aravalli region: a number of parallel ridges running North East and South West, separated by broad valleys.

(4) Geologically the region is constituted by the quartzites and schists of the Aravalli system forming a series of highly compressed paralled folds. The ridges consist principally of quartzite which, owing to its hardness and inalterability resists desintegration better than the schists of various sorts constituting the intervening valleys. It is not possible to say in the present stage of our knowledge regarding the geology of the region whether the quartzites of the successive parallel ranges are repetitions of one band, or separate bands occurring at different geological horizons. The rivers are mostly disposed longitudinally along the flat valleys separating the parallel ridges. The altitudes of the valleys relatively to one another do not differ much, and these differences do not follow any particular law, as the general

slopes of these valleys may be in one direction or the other according to the direction of drainage. For instance one river may be flowing North eastward in one valley, while in the adjacent one it may be flowing South-west.

(5) A structure such as the one above outlined is unsuited to the existence of artesian conditions. Artesian conditions require that a particular porous bed should outcrop over a fairly large area and from there descend beneath a lower lying region under an impermeable covering.

(6) The primary conditions for an artesian supply are wanting. The compact rocks of the aravalli formation, except where decomposed in the neighbourhood of the surface, are not porous, and can only become water-bearing as the result of fissures whose disposition is too uncertain and too irregular to justify the sinking of deep wells. Although the strata outcropping in certain valleys may sink beneath the floor of another valley whose surface is at a lower altitude, the small difference of altitude from one valley to another, the compactness of the strata and the absence of regular alternations of beds of different degrees of porosity absolutely condemn all reasonable chances of obtaining a large supply of water under pressure from great depths. The hills consist of rocks that are no more porous than those of the intervening plains, and being mere narrow ridges do not in any way effect the water-bearning conditions in depth. Owing to their comparatively insignificant dimensions, and also to the lesser degree of aridity of the region, their slopes are not accompanied by the great talus of debris that skirts the mountains of Baluchistan, Persia, and Central Asia and stores the water supply which, in those countries is tapped either by artesian wells or by the karez system.

(7) The only supply of water that can therefore be drawn upon in the case of this city, is that whose upper surface is not under pressure, and which may be spoken of as "ground water." Of this, there appears to be a practically unlimited supply so far as city requirements are concerned and the water level is everywhere at a very moderate depth. Ajmer being situated at a higher altitude than most of the surrounding country, any serious addition to the present scheme will involve raising the supply by artificial means. It seems unnecessary therefore to have recourse to the system of making artificial tanks, such as those that have already been made in the only part of the surrounding country that commands the level of the town, and whose chief recommendation is the aid of gravitation in distributing the supply. The creation of new tanks being set aside as unnecessary, the scheme that suggests itself is that in use in many other towns, of obtaining a water supply from large wells sunk where the flow of ground water is most abundant, that is in the bed of a river.

(8) The two principal river valleys situated respectively east and west of Ajmer, that is the Sagarmati and the Sarsuti, appear to answer to all desired requirements. So far as I can make out from my observations unaided by actual measurements, it is the Sagarmati that has the largest flow. The yield of the Sarsuti may be less than that of the Sagarmati ; there seems no doubt however, that it will amply suffice.

(9) It is important to form a definite idea of the superabundance of water in the neighbouring district with reference to the requirements of a city. The following considerations are based upon very rough estimates, but in any case they leave such an enormous margin that any approach to greater accuracy is quite superfluous. Judging by statements made to me during last few days, wells with a rate of percolation of some 1,200 gallons an hour will irrigate an area of some 30 bighas. One well of this capacity represents about one thirtieth of the water supply of Ajmer. The entire water supply of this city, if turned to irrigation would just suffice therefore for half a square mile It is a well known fact that an artesian well amply sufficient for the needs of a large city will only irrigate a comparatively small farm. This has had to be repeatedly insisted upon whenever impracticable schemes have been submitted to us as to the possibility of obviating the chances of famine by sinking of artesian wells ; or other artificial means of the same degree of efficiency. Fortunately, in the present case, the argument works the other way round. In a region where a certian amount of irrigation can be carried on even during the worst droughts, the supply of a town reduces itself to selecting one amongst a number of possible schemes.

SAGARMATI VALLEY

(10) The upper course of the Sagarmati, above, Ajmer, feeds the Foysagar and Anasagar tanks regarding which I have nothing to add to the recommendations made in the Executive Engineer's report (Proposals 4, 6, and 8). The proposed well in the bed of the Anasagar should be made at or near the deepest part of the bed, not too near the dam, so as not to risk inducing leakage. I do not know what is the exact contour of the bed when the lake dries up, but it would be probably perfectly safe to select the lowest point situated some 500 feet from the dam. I cannot help feeling doubtful as to the quality of the water, but it could be used for watering gardens. At any rate it would be interesting, as soon as the lake dries up, to sink such a well, and pump as much water as possible from it so as to get some idea of the length of time during which the supply could be kept up.

(11) The well which is being excavated below the dam of Foysagar had not, on the day I visited it (6th April), struck any important spring. With the exception of the first 5 feet, it is

entirely through rock, (micaschist). The total depth on the day of my visit was 19 feet. One foot of water percolated during the night. Before ceasing to deepen it, it would be as well to find out how it compares, as regards depth, with other wells along the same valley, between Foysagar and Anasagar. Accurate measurements of the yield of these wells would be interesting. If eventually the Foysagar well yields no water, it can be converted into a convenient reservoir, from which to pump the water percolating from the tank, as was suggested when it was proposed to excavate this well.

(12) The trench in the Beesla tank, on the day that I visited it (6th April), had traversed the whole thickness of the alluvium, and was being deepened in the underlying rock, with a very feeble percolation. The chances of striking a water-yielding fissure in compact rock are so uncertain that the experiment might probably be discontinued. The trenches excavated in the bed of the Anasagar in 1892, probably did not penetrate the rock. Before ceasing the experiment, it would be advisable to test all the wells in the Bisla tank, and find out whether their yield is proportionate to their area. If so a proportionate yield might be anticipated in the trench at the same depth.

(13) There are several wells in the bed of the Beesla tank only one of which appears to have been measured (Chitar Khan and Ballu Sheikh's well). At a depth of some 39 feet, the percolation is only about 200 gallons an hour. It is excavated through rock. The diameter is 6 feet and the yield is therefore about 7 gallons per hour per square foot of area. It would be probably useful to restore the tank and thus raise the level of subsoil water in its neighbourhood, but its capabilities do not seem sufficient to justify much expenditure.

(14) From the Beesla tank to Dorai village, the alluvium of the Sagarmati is of insignificant thickness. Just below Dorai its thickness increases considerably in the neighbourhood of the water-course, and from there, down the valley, it constantly increases in importance till it joins the great alluvial spread of the Banas.

(15) Between the 4th and 5th milestone from Ajmer, less than ½ mile from the road, on the western side, there is a large well belonging to the village of Somalpura, excavated in rock (a very hard, compact hornblendic schist). At a depth of about 58 feet, the percolation is more than 2,500 gallons an hour. Fourteen wells of this capacity would suffice for the maximum requirements of Ajmer. The well is of very large size, with a diameter varying from 30 to 32 feet. The yield per square foot of area is therefore only about 3½ gallons, that is just half that of the well measured in the Beesla tank. The Somalpura well is

said to have been in existence for the last 20 years. Its yield was originally much smaller than at present, the orignal depth being also much less. It dried up or nearly dried up in the drought of 1900, and was then deepened, with the result of a considerably increased yield.

(16) There are several other wells in the immediate neighbourhood of the one just mentioned, none of which are as good according to verbal accounts. These cannot be relied upon without actual measurement, and the size of these wells must also be taken into account. It is as well to keep in mind that the yield from a compact rock such as the one at Somalpura varies greatly from place to place, depending largely, as it does, upon fissures whose position cannot be anticipated. In the present case, the alluvial area which commences opposite the 5th mile near Dorai, will probably be found more suitable.

(17) I was shown a well situated south of the village of Dorai, close to the bed of the Sagarmati. Its total depth is 40′-5″, entirely through alluvial formation. The greater part of the depth is through loose soil and pebbles. At the bottom there is a layer of "Kankar," which is a compact calcareous conglomerate, also belonging to the alluvial formation. I have not measured the diameter of the well. It is much less than in the case of the one at Somalpora. It would be important to test this well, and if the result is favourable, it may not be necessary to go any further down the valley of the Sagarmati for a water-supply. Other experimental wells might be sunk in this same neighbourhood, either in the actual river-bed or quite close to it. When I saw the well on the morning of the 7th, it was being worked. It contained 11 feet of water, and a considerable flow of excellent water was running down the irrigation channel.

(18) Before reaching the 6th milestone, there is a large "baoli" whose total depth is 53′-4″. It is largely excavated through rock (pogmatite). It contained 18′-10″ of water when I saw it on the 7th. It is said to irrigate an area of 37 "bigas", yielding three crops, and not to be affected by dry years. The quality of the water seems excellent. Its percolation should be tested. It is situated at a distance from the bed of the Sagarmati and at a higher level.

(19) South and south-east of Dumara is a very extensive flat area, entirely under cultivation. There are numerous shallow wells in which the water is slightly brackish, though fit for irrigation. The flatness of the area and indecision of the drainage probably account for the gradual accumulation of salt. The wells are entirely through alluvium.

(20) Good water is yielded by a well (Hari Singh's) situated west of Dumara on rising ground north of the Sagarmati. Although it is situated some distance up the slope leading up to the hill yet it does not reach the rock, being sunk through sand and soil, upon a wooden curb, to a depth of over 45 feet. From a geological point of view, it is therefore the only well that I have seen in this district, which somewhat approaches the conditions of the karez wells in the great talus slopes of Baluchistan. The scale of the talus and the yield of the well are, however, both insignificant when compared with similar features along the north-western frontiers of India. The percolation is a great deal over 1,000 gallons an hour at a depth of 42 feet. (See detailed statement by Executive Engineer). The diameter is 19 feet, and the percolation therefore some 4 gallons per square foot in an hour. The level of the water on the day of my visit, (6th April), was 36′-3″ below surface. The well is said to be out of repair.

(21) As one descends from this well southwards or south-westwards towards the Sagarmati, the relative depth of the ground water surface becomes rapidly shallower. In this neighbourhood I was shown several wells yielding excellent water. One belonging to Bur Singh and Bijei Singh, with a total depth of only 22 feet is said to irrigate 64 "bigas" yielding two crops. As it has four "charas" fitted on to it, these statements are probably not exaggerated. All these wells some of which appear to belong to Dumara and some to Masina village should be carefully tested.

(22) North of Masina, as marked on the map, the sandy bed of the Sagarmati expands considerably and every where contains water up to 1 or 2 ft. from surface, the actual surface being moist in many places. The water looks and tastes very pure. The river bed is, at present, being planted with melons. By the time the Sagarmati has reached this point, its drainage area has become considerable, probably not less than 70 square miles. Its valley is, at this place, narrow, and, occupied, to a great extent by the actual river-bed. Trial excavations might be made to get some idea of the rate of flow, but there is no doubt that at this place there is enough water to supply many times the needs of Ajmer. The distance and difference of altitude are the only objections to the use of this supply. I am under the impression that it is the best supply in the neighbourhood of Ajmer, but it is quite possible that a sufficient though less superabundant supply might be obtained more economically from some other spot.

The most convenient solution would be, perhaps to pump it up the gorge north-east of Amba, and then connect it by gravitation with the Foysagar system.

(23) Still farther down the Sagarmati valley, towards Bhaonta, there are numerous wells with a large yield. I was shown one situated about a mile north-east by east of Bhaonta,

and south by west of Amba it is worked with six "charas", though its diameter is not much more than 6 feet. It was being tested at the time of my visit, but I do not know yet the result of the test. Evidently the yield is very great.

(24) Conclusions.—The valley of the Sagarmati below Ajmer constitutes the area most likely to yield a considerable addition to the present water-supply of the city.

(25) Attention should be specially devoted to the alluvial area commencing at Dorai. The sinking of wells in rock, as at Somalpore is uncertain, and the yield relatively to the area of the well is small. The wells in the alluvium at Dorai should be tested and the river-bed in that neighbourhood experimented upon.

(26) The levels of the gorge at Amba should be surveyed with a view to the possibility of raising the supply from the river-bed opposite Masina, so as to connect it with the Foysagar system.

(27) I should like to know the results of a test of the river-bed opposite Masina. But even without such a test, I have no hesitation in stating that it contains much more than is needed for Ajmer. I believe that there is some difficulty in obtaining sufficient water-supply for the Cantonment at Nasirabad. If the cantoment were removed to Bhaonta the surplus from the Ajmer scheme, or merely the Bhaonta wells would probably amply suffice. When all the tests have been completed; the feasibility of this proposal might be taken into consideration.

SARSUTI VALLEY.

(28) I entered the Sarsuti valley at Galti. This village is situated at the foot of an extensive slope of blown sand. It is possible and probable that the rainfall is somewhat less in the Sarsuti than in the Sagamati valley, but the prevalence of blown sand in the Sarsuti valley can scarcely be connected with any marked difference of climatic conditions. The proximity of the desert of Western Rajputana no doubt accounts for its presence. It is brought by the westerly winds and is arrested by the steep ridges that separate the Sarsuti and Sagarmati valleys. These sand slopes must act as effective water-reservoirs, in a manner comparable to that of the talus slopes of Baluchistan already several times referred to. At Galti village, at an altitude appreciabily greater than that of the Sarsuti plain, the water of a shallow well sunk in the sand is only at 6′-5″ below the surface. It sinks in dry years but apparently does not dry up. The water is very pure.

(29) Where I crossed the Sarsuti between Galti and Dongri, on the 9th April, there was water flowing in the river-bed. A slight efflorescence was noticed on the surface of the soil near this spot, showing that the soil must be slightly salt. Rock is seen at

several places in the river-bed in this neighbourhood, and the thickness of alluvium must be irregular and insignificant. The place struck me as one favourable for a dam, which might not be directly useful, perhaps, in the Ajmer water-supply, but would contribute to raise the ground-water level, and might be made use of for irrigation. Probably other dams could be thrown across the river-bed at other points higher up its course.

(30) At Dongri I was shown two wells sunk in rock, and situated at some height above the level of the rvier-bed. I have no accurate figures regarding their yield. One of them is said to irrigate 15½ "bighas." These wells might be tested, but it would be more promising to make experiments in the sand of the Galti side of the valley, rather than in the rock on the Dongri side. Moreover, Galti is much closer to Bndha Pushkar. Below Dongri, the valley of the Sarsuti is occupied by alluvium, which appears to be of fair thickness, and ultimately merges into that of the Sagarmati.

(31) Opposite Khera-Tilora, the bed of the Sarsuti did not show any water at the surface. The water-level seems to be 4 or 5 feet below surface at present.

(32) Further down the valley, at Chaondia, near Pushkar there are several wells which are situated at a higher level than the bed of the Sarsuti, and appear to yield an abundant supply. Detailed observations on one of these wells are given by the Executive Engineer. At depths of from 22 to 30 feet, the percolation is over 1200 gallons an hour. The diameter is only 6½ feet and the percolation not far from 40 gallons an hour per square foot. The well is sunk entirely through sandy soil,and it is improbable that it could represent the yield of a local spring such as those met with in fissured rocks. If, as seems probable, it merely taps a uniform subsoil flow, a well in the same neighbourhood with a diameter of 34 feet might suffice for the needs of Ajmer, the yield of the one well tested being more than one thirtieth of requirements of the city. There are not data sufficient to assert that volume of water thirty times that yielded by this particular well flows beneath Chaondia, but the deficiency, if any, could be made good from other neighbouring localities, or it would probably be sufficient to go direct to the bed of the Sarsuti.

(33) It may be noticed that when testing this well on different occasions, the Executive Engineer, and the Railway officials started their tests when a depth of over 4 feet of water still remained in the well. The figures do not therefore represent the maximum possible yeild. When the depth of water is reduced to less than 4 feet, a great deal of sand is carried in with it, and there is a risk of injuring the well by leaving it unsupported. The same trouble is more noticeable in dry years than in normal ones, the yield

still remaining otherwise unaffected. The small diameter of the well accounts for these facts, which indicate a considerable pressure in a very porous and rather incoherent soil when the water is lowered beyond a certain level. An increase of diameter, by distributing the percolation over a greater surface would obviate this difficulty, (so long as the same amount of water is drawn out.)

(34) Conclusion.—There seems no doubt that the supply available from the Sarsuti is amply sufficient, though the available data are not quite so ample as in the case of the Sagarmati.

(35) Experimental wells should be sunk at Galti, in or near the river bed between Khera-Tilora and Basali, about Chaondia, and west of that village towards the river-bed.

(36) I understand that the water level is lower than it used to be over a considerable area formerly planted with sugarcane. The construction of a dam west of Chaondia across the river-bed might tend to restore the former conditions. This is not essential, however, with respect to the Ajmer water-supply scheme.

Budha Pushkar.

(37) This natural lake indicates the existence of an abundant store of water in the surrounding sand hills which probably account for its formation by interrupting the drainage. There is no visible outflow, though the fact that the water is sweet indicates that an outflow, does exist underground, and consequently that the store is also replenished. A reservoir of this sort is probably very slowly affected by fluctuations in the annual rainfall it would probably remain unaffected by a period of drought for a fairly long period after the rainfall had again become normal, while, at the same time, a dry year will not affact it to the same extent as it would a more superficial reservoir. I do not know whether there are any accurate records of its fluctuations of level, nor whether any connection has been observed between these and the amounts pumped from the lake. If the available data are not sufficient to form any sound conclusion, it is best to leave the lake untouched as a valuable reserve in case of an exceptionally severe scarcity. I am of opinion that the visible capacity of the lake does not express the available amount of water, as this no doubt percolated from the surrounding sand hills.

(38) There are similar basins surrounded by sand hills in the Nushki Desert of Baluchistan, in places where it does not rain for years at a time. As they do not dry up and as they contain sweet water, there must be a constant flow representing percolation from the sand hills. Its only source can be occasional showers.

MADARPURA, KIRANIPURA.

(39) I examined the Madarpura valley on account of its being represented on the geological map as occupied by alluvium. The circumstances, however, are not encouraging. The valley is on a watershed, with a very small drainage area. The alluvium is shallow and is entirely traversed by the wells which extend to a considerable depth into the rock below.

(40) I saw a well situated about the centre of the valley north of the road to Srinagar. It is dry. Another well near the eastern edge of the valley is 77 feet deep. It contained 21 feet of water when I saw it (April 7th). It is said to irrigate about 9 "bigas" which seems correct judging from the area of the fields which it commands.

Another well, south of the road, also contains water. It is also very deep. I was told that it yields a poor supply, which, however, needs confirming.

(41) The physical situation of these wells does not seem promising, and it is not worth testing them so long as there are more urgent experiments to be made.

(42) There are several large wells above the dam of the tank at Kiranipura. Two of these which I visited are respectively 82 and 86 feet deep. The first of these is worked throughout the day with four "charas." It is said to fill again during the night the water-level rising by 20 feet. These statements are worth verifying, for they seem to indicate a very large yield. It might be found that these Kiranipura wells, situated quite close to the city might supply an appreciable share of its needs. There would be probably a heavy compensation to pay, for the land irrigated seems very valuable. It is planted with roses and jasmine.

(43) I was told that the 82 feet well used to become exhausted twice a day in 1900, instead of only once as at present. Even then the yield would seem very large. I unfortunately omitted to note its diameter. This is, perhaps not less than 16 feet in which case the statements made to me would indicate a percolation of not less than 2400 gallons an hour, and 11 gallons for every square foot. The well should be systematically tested.

(44) The 86 feet well is said to have become "insufficient" in 1900, 1902, and 1906. The exact meaning of this statement is uncertian.

(45) In conclusion, it is evident that these Kiranipura wells should be carefully tested, and their behaviour during the past dry years ascertained as far as possible. When these data have been collected, it will become possible to consider whether they can enter in the improvement scheme.

Kair Tank.

46. With regard to Kair tank, the data available will scarcely suffice for drawing safe conclusions. We only have one test of one well below the dam, performed in March 1905. The condition of the tank at the time of the experiment is not stated but the previous rainfall must have been fairly good, for the tank is said to have contained 13·55 million cubic feet in 1904 against only 7·75 in 1906. The infiltration at time of the experiment was about 2500 gallons an hour. The diameter of the well is not stated. I did not measure it, but it is fairly large, I should say not less than 15 feet. This would give a percolation per square foot of area of about the same order as that of the wells at Kiranipura.

47. Fresh trials should be made this year in this well and other neighbouring ones after the Kair tank has dried up. The villagers told us that the wells dried up last year, but these statements are not very reliable. Any how, further data are needed before the case of the Kair tank can be seriously considered.

48. For improving the water-supply of Ajmer there are two schemes which appear very suitable. One is to obtain water from the Sarsuti or its neighbourhood near Galti or Chaondia, and pump it over the sand ridge at Galti so as to connect it with the Budha Pushkar system. The second scheme consists in sinking large shallow wells in the bed of the Srgarmati opposite Masina, and pump the water through the Amba gorge, to connect it with the Foysagar system. The latter scheme seems to promise the more abundant supply and necessitates pumping the supply only once, while in the case of the Sarsuti scheme, the water has to be raised twice, first over the Galti ridge, and then over Pushkar one.

49. In connection with the Sarsuti scheme, tests should be commenced at the points that I have recommended when dealing with the Sarsuti valley. In connection with the Sagarmati scheme, the tests will have to be made, in the broad expanse of the river opposite Masina.

50. The Sagarmati should also be tested at Dorai in case there is any economical advantage in drawing the supply from this spot rather than from Masina.

51. The capabilities of a well sunk in the bed of the Anasagar should be thoroughly tested after the lake has dried up in the present season.

52. It would be advisable to avoid using the water from Budha Pushkar so as to give the lake every chance of recovering itself. The complete efficiency of the Sagarmati or Sarsuti schemes will not be proved by actual practice so long as we do not get a year

of severe drought. It is most unlikely that either of these schemes would fail even then. But in case of partial failure, then Budha Pushkar would remain to fall back upon, and then it would be thoroughly tested. I am inclined to think that even with the present scheme, Budha Pushkar constitutes a sufficient reserve. But this has never been ascertained, and it is too valuable a reserve to experiment upon so long as an alternate scheme is not in existence.

53. Kiranipura and Kair cannot be taken into consideration without further tests. Kiranipura would certainly imply heavy compensation. The Sagarmati and Sarsuti schemes should imply little or no compensation.

54, The Bisla tank improvement does not seem important enough to justify heavy expenditure.

55. I shall be on leave during the next three months, but if, in the meanwhile, the results of any of the tests recommended in this report should call for the necessity of further advice, I hope that the Director of the Geological Survey of India will be able to give the services of one of my colleagues for this purpose.

(Sd.) E. VRENDENBURG,

Ajmer, 11th April 1907. *Geological Survey of India.*

APPENDIX B.

A SANITARY SURVEY OF AJMER.

In a note, dated the 3rd May 1906, the Sanitary Commissioner with the Government of India remarks as follows :—

> "In my opinion a sanitary survey of Ajmer with schemes for the increase and improvement of the water-supply, for the efficient removal of night soil and sullage, and for the draining and paving of the city should be prepared under the Superintendence of an Engineer experienced in dealing with such schemes. The schemes could then be carried out gradually as funds become avaliable. The alternative is the frittering away of large sums on measures of palliation involving a great waste of money and the continuance of nuisances which are offensive to the senses and dangerous to life."

At the instance of the Government of India, I have been deputed by the Government of Bengal to undertake this survey, and it will probably be convenient if I treat the subject under the three heads mentioned by the Sanitary Commissioner. I arrived at Ajmer on the 2nd May 1907, and after a careful inspection of the town and surrounding country and a perusal of the papers relating to these subjects I think I am now in position to offer some preliminary suggestions as to what should be done in the first instance to obtain the objects indicated by the Sanitary Commissioner. I am afraid that my suggestions, if approved, will take some time to carry out and will mean great delay before any real improvement in the sanitary condition of Ajmer can be effected, but after some years' experience in sanitary works, I have been forced to the conclusion that they are works that should not be undertaken without the most careful and searching preliminary enquiries. These are much more necessary in sanitary work in India than in any class of work I know of for failures dishearten local bodies whose incomes are not very large and whose borrowing capacities are correspondingly limited. From the last annual report of the Ajmer Municipality, it would appear however that financially the town is much better off than many others; its debt is very small and its cash balance at the end of the year 1905-06 enormously, and in my opinion unnecessarily, large. I may state at once that I can hold out no hope of its being possible to effect any real improvements in the sanitary condition of Ajmer within the next two years at the very earliest for everything, as will be seen hereafter, hinges on the efficiency of the water-supply. Cleanliness of one's own person is impossible without a plentiful supply of good water and it is the same with towns; only, comparatively larger supplies of water are required on account of the great waste that goes on.

WATER-SUPPLY.

2. The sources of the water-supply appear to be many and various. The greatest quantity of water supplied to the town proper is obtained from the Foysagar, and at the present time the water is deficient in quantity and quality. From papers that have been placed before me it appears that this water has been consistently declared from chemical analysis to be unfit for potable purposes: in fact, in the Annual Report for 1897-98 it is recorded that "one sample from a road hydrant was found to contain germs of enteric fever." Judging from the crowds of people gathered round the standposts, it would appear that the distribution system is faulty also: either the standposts are too few in number or the pipes are too small and consequently the water does not issue from the standposts quickly enough. In all properly designed systems it should be possible to draw off from each tap at least 6 gallons a minute. The other sources of supply are Colonel Dixon's Diggi; the Jhalra, the Katan Bao and numerous private wells. I inspected the Diggi and am bound to say that I have seldom seen a more disgusting-looking water being used for potable purposes and yet I was told that the people preferred this water to ordinary tap water. The Jhalra water appeared to be in great demand, and both it and the water of the Katan Bao were quite satisfactory as far as appearance goes. I think, however, that if samples of water from the various water-supplies were thoroughly examined bacteriologically both qualitatively and quantitatively, that is to say for the presence of the bacilli of the coli group per cubic centimetre, the results would not only be surprising but alarming and I would suggest that enquiries be made as to whether the services of Professor Hankin of Agra could not be obtained to make these examinations on the spot. In this connection I would point out that it is a duty incumbent on every local body that undertakes the supply of drinking water to ascertain from time to time that the water that is being supplied is of a good potable quality and not dangerous to the health of the consumer.

3. From a casual study of the vital statistics as given in the Municipal Reports, it would appear that the inhabitants suffered but little ill-effect from drinking the dirty water I have described in the foregoing paragraph, and I must say that I was extremely surprised at this. The civil Surgeon kindly supplied me with a statement of mortality in Ajmer for the past 30 years, and on examining this I find that the general death-rate was, higher in 1906 than it had been for the previous 20 years, omitting the famine years of 1899 and 1900. The death-rates from the principal diseases in which impure water plays a part, during the previous 10 years, were as follows :—

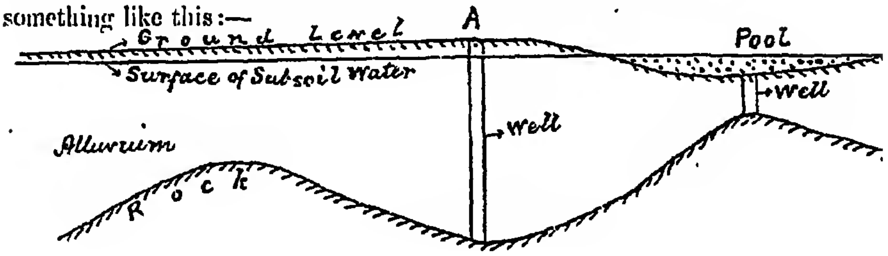
Cholera 0·16, fever 17·47 and bowel-complaints 4·06. I am bound to say that it is an extraordinary thing that there are not more deaths from cholera, but probably the germs are unable to live through the excessively dry heat. It would appear that fever is accountable for the greatest number of deaths and under this head is included of course enteric fever. I was informed by one or two residents that the number of cases of enteric fever was certainly increasing, but then the germs of this disease can be conveyed through milk as well as water. The death rate among children under five years of age was in 1906 46·68 per cent. of the total mortality, and it is quite possible that enteric fever was responsible for most of the deaths.

In 1906 the death rate from fevers was 26·03 or 50 per cent. above the average of the previous 10 years, while that from bowel complaints was 38 per cent, above. These figures must I think be viewed with alarm and I would most earnestly urge the Municipal Committee to have a complete bacteriological survey of every source of drinking-water supply made. There can be but little doubt that the death-rate in Ajmer is increasing instead of decreasing, and an ample supply of good wholesome drinking-water will go far to produce a normal state of affairs.

4. A few weeks previous to my visit Mr. E. Vrendenburg of the Geological Survey of India had made a thorough examination of the other possible sources of water-supply for Ajmer, and it was a great advantage to me to have his note placed in my hands on my arrival here. It is perfectly clear from this note that a grave mistake has been made in the past in attempting to store water above ground on a very pervious subsoil and in a climate where evaporation is very rapid, instead of tapping the great underground rivers of subsoil water travelling down the alluvial valleys over impervious rock. Mr. Vrendenburg has recorded that " The valley of the Sagarmati below Ajmer constitutes the area most likely to yield a considerable addition to the present water-supply of the city " (*vide* paragraph 24), and further " There seems no doubt that the supply available from the Sarsuti is amply sufficient, though the available data are not quite so complete as in the case of the Sagarmati" (*vide* paragraph 34). Mr. Vrendenburg finally states in paragraph 48 that wells sunk opposite Masina, or perhaps Dorai, in the Sagarmati valley would appear to be capable of giving a suitable supply. *Primâ facie* it would seem that a new and complete water-supply scheme would be a very simple matter and that it only means the sinking of wells or building of collecting galleries in the beds of the rivers, the setting up of pumping plant and the laying of a few miles of pipe and the whole question would be satisfactorily settled once and for all. As I shall show in the succeeding paragraphs, the matter is not so simple as it seems and very much more work must be done and

information collected before it will be possible even to set about getting out the necessary designs and estimates.

5. It is a well-known fact that the bed of the ocean is just as rugged and mountainous as the surface of the dry land, similarly the beds of valleys in rocky tracts are as uneven as the hills that border on them. The process going on in nature is the denudation of the hills and the filling up of the valley with the wash-down or alluvium therefrom, and there can be no doubt that the sides of the hills and spurs therefrom slope down under the alluvium in the valleys. If then a longitudinal section of the deepest part of a valley in hilly country were made, it would be found to be something like this:—



The subsoil water is constantly moving towords a lower level and for this to take place the surface must be on the slope. The ground is not at an uniform level and where it falls below the level of the subsoil water, a pool or lake is formed as shown in the sketch. Now suppose a well were sunk in this pool and it so happend that rocks were found very near the surface (shallow well) and heavy pumping was commenced, the level of the subsoil water would be reduced after a time and in a year of scanty rainfall it might be reduced down to the level of the rock at the bottom of the well, and the well would be said to have run dry. If however a deep well were sunk at the point A, it would not run dry until the whole of the subsoil water stored on the basin between the two ridges of rock have been pumped out. Before therefore the sites of the wells in the Sagarmati or Sarsuti valleys can be decided. it will I think be admitted that it is most necessary to have a longitudinal section of the rocky bed of the valley made two or three miles at least above and below the points indicated in Mr. Vredenburg's report. This can be done either by means of wells or possibly at less cost and more quickly by boring. The best procedure to follow probably will be to decide on the sites of the wells or bore holes and fix bench-marks at each of them, the reduced levels of the rock and the subsoil water underneath can then be easily ascertained by simple measurements as the bore holes or wells are completed. Where the rock is deepest below the surface, a transverse or cross section of the valley should also be made so that some idea may be obtaianed of the extent of the depression in the rock bed from which it will be possible to arrive at some conclusion as the quantity of subsoil showed in the basin.

Unless and until this information is obtained, it will be quite impossible to say what design of pumps would have to be adopted, for where the water does not fall below 20 feet below ground level the pumps can be kept at that level, but if this depth is exceeded the pumps must be correspondingly lowered.

6. As soon as the best site for the pumping station has been decided on from the information obtained as recommended in the preceding paragraph, it will be necessary to sink a trial well and pump from it continuously for at least six weeks at the driest time of the year in order to ascertain the best size of well and the number to give the daily supply required for the town. In this connection I would state that I have handed over to the Executive Engineer a copy of a report on a similar experiment that was carried out under my direction on a well sunk in an old bed of the river Sone in Bengal, and I would suggest that the experiment for Ajmer be carried out on similer lines, although it is quite possible that the local officers can improve on the methods for instance meters are available here I believe and so the yield might be more accurately measured through them instead of over a notch.

7. It will be convenient at this stage to discuss the question he quantity of the daily supply, and it will perhaps clear the 'f I state at once that I would recommend that the whole of rinking water supply be obtained either from the Sagarmati ..rsuti valleys and the Foysagar water be used only for conservancy and manufacturing purposes and for watering gardens. I am aware that this means an absolutely new drinking water supply, but the existing pipes would appear, to be in need of considerable remodelling if an efficient distribution system is to be maintained in Ajmer. In years of short storage in the Foysagar the supplies to gardens should be first cut off; this no doubt will be considered rather a hardship by owners of gardens, but gardens are aluxury and a necessity. If the shortage was excessive, the connection for manufacturing purposes would have to be cut off, but the Railway Workshops is the only connection that takes any large quantity under this head and the Railway Administration would still have the Budha Pushkar tank to fall back on. This tank certainly shows signs of drying up, but it has I understand been rather heavily drawn upon during the recent dry years, and it is possible that it might fill up again to its original level in years of normal rainfall. During the year 1905-06 the total consumption of water stated in the Annual Report to have been 24,16,10,000 gallons, but of this quantity 58,110,000 gallons were used in the Railway Workshops. If this latter quantity is deducted, the daily average quantity was just about 7 gallons per head; but this supply was obtained from the Foysagar alone and, as has been shown above, large quantities of

water are obtained from other sources. There are 87 private connections, of which 6 took over 1,000,000 gallons during the year 1905-06. These are such excessive consumptions for private consumers that I think they should be left out of any calculations for attempting to arrive at the probable consumption for domestic purposes, but even by omitting these I find that the average daily consumption of the other 81 private connections was 1,000 gallons. It is perfectly clear to my mind that the Municipal water is being used for other than purely domestic purposes. This may be all very well when water is obtained fairly cheaply as by gravitation; but if the water has to be obtained by pumping from works costing a considerable sum of money, some control must be exercised over the purposes for which it is used. If it is assumed that one-half the total quantity used by private connections during the year 1905-06 was for domestic purposes, while the other was used for gardens, we shall find that the quantity of water supplied to the whole population was only about 5 gallons per head. In an extremely hot and dry climate like that of Ajmer, this is an altogether inadequate supply, and in my opinion any new scheme should provide for at least 10 gallons per head, and if funds are available, for 15 gallons. Until an ample supply of good drinking water is supplied, it will be useless to think of trying to close up the other dangerous sources of water-supply for I regard all tanks or wells whence water is obtained by the indiscriminate dipping of private vessels and *mussucks* as open to the gravest objections.

8. To sum up my recommendations in the matter of water supply, they are as follows :—

(*a*) After the most careful and searching preliminary enquiries to obtain a supply of water for domestic purposes only from wells sunk either in the Sagarmati or Sarsuti valleys.

(*b*) The daily supply to be on a basis of 10 and if possible 15 gallons per head to be raised from the wells by continuous pumping throughout the 24 hours, a sufficient reserve of pumping machinery being provided to allow for necessary stoppages for repairs, allowance to be made for increase in population in next 30 years.

(*c*) The rising main to be of sufficient capacity to deliver the whole daily supply in 24 hours.

(*d*) A service reservoir to be erected in some suitable spot to be decided hereafter, of sufficient capacity to meet the periods of maximum demand from the distribution system.

(c) A distribution system of sufficient capacity to deliver the whole daily supply in 6 hours, care being taken that the main pipes pass through the highest parts of the town before they descend to the lower parts.

The valley of the Sagarmati as far as Masina is much larger in area than that of the Sursuti as far as Chaondia and a larger supply of water should therefore be obtainable from the former, and if the enquiries that I have recommended above show that a very ample supply is available in the Sagarmati, then it would be possible to supply water to Nasirabad and thus save all the expense of the removal of the Cantonments which I understand is under contemplation.

CONSERVANCY.

9. I do not propose to deal in this report with the question of the sufficiency of public latrines and urinals because that is a matter for which much knowledge of local requirements is necessary. If it is found that in any quarter of the town there is much urinating at the street sides, it is a fair sign of the necessity for a urinal; similarly, if the receptacles in the public latrines are found to be overflowing every day more latrine accommodation is indicated. I was supplied with a statement showing the number of latrines and urinals with the number of seats in each and speaking generally these were satisfactory, but as far as latrines are concerned, where there is a large number of seats such as that in sub-ward No. 1, where the only public latrine has 36 seats and those in sub-ward No. 5 where each has 28 seats they are apt to be a nuisance to the immediate neghbourhood. It is much less offensive to have several latrines with a few seats than a few with a large number; similarly it is much more convenient for the people to have several single seated urinals than a few with three or four seats. In all public latrines the collection of the urine and fæces in separate receptacles should be a *sine qua non* and it should be insisted on in private privies as far as may be. The sullage and liquid wastes of houses is collected not in cess-pools within the premises but in receptacles, iron and wooden, placed out in the streets. This is a most excellent system I have no doubt from the house-owners' point of view because it removes a centre of nuisance outside his property and also because it will be possible for him to claim the portion of the street on which his receptacle has stood for years as part of his property, but as far as the general public is concerned these receptacles must be an eye-sore and a nuisance. There is only one remedy for this state of affairs and that is to provide small masonry drains at the sides of the streets and gullies to carry off the liquid wastes as soon as they are produced, but I shall deal with this subject under the head of drainage.

10. The system in vouge for the collection of nightsoil from private privies is one which I have not come across before. There appears to be a class of sweepers, known as "birat mehters" who undertake this work and who are paid not by wages but in kind by the householders whose privies they cleanse, the Municipality paying them nothing. This system is universal in the town area. At first sight it would appear to be an impossible system, but the Municipality appear to have sufficient control over the mehters, and I am further informed that it would be almost impossible to change the system and upset vested interests. These mehters have to convey the nightsoil in baskets to the Conservancy Tramway and no carts are used for the nightsoil from private privies. The nightsoil as it is removed from the privies is covered with ashes or dust, and I am bonnd to say that from what I saw during my visits to the town area the removal is done with little or no nuisance. The Railway administration make their own arrangements for the collection and removal of the nightsoil from the Workshops to the tramway, and in all other cases private sweepers have to carry it to that point, unless the Municipality are asked to do it in which case a scavenging fee is charged. All liquid filth and sullage and street-sweepings are collected by the Municipality, the former being carried out by the Conservancy Tramway to the trenching ground, while the latter is dumped on waste ground in the town. In every sub-ward there are at least two peons, and in the town four, whose business it is to supervise the work of the mehters. For every two town sub-wards there is a jamadar for to look after the peons, but in the suburban wards there is one jamadar each. The work of the jamadars is supervised by two Sub-Inspectors on Rs. 35 per month each—one for the town and one for the suburbs. The whole of the conservancy arrangements are controlled by an Inspector on Rs. 110 per month. Some 10 years ago the Inspector had the nightsoil of a building occupied by 20 persons weighed and fonnd it amounted to abont 1¼ lb. per head per day or about 10,000 tons, per 50,000 persons per year. If this weighment was at all correct the total solid excreta of a population of 73,839 persons would amount to 18,768 tons but I find that in 1905-1906 only 13,877 tons was removed by the Conservancy Tramway, leaving a balance of 5,000 tons unaccounted for, but I am told the Merwara Battalion and the Mayo College have their own trenching grounds so perhaps the total quantity of nightsoil produced is actually removed. In the course of one of my inspections I noticed a train of trucks going down the tramway at 7 o'clock in the evening and on enquiry into this, the fact came out that the removal of nightsoil and sullage is practically going on all day. The privies may possibly be cleaned in the morning, bnt the collection of sullage goes on morning and evening and these sullage carts

are certainly offensive. Measures ought to be adopted to have the collection of the nightsoil and sullage finished by 10 A.M. at the latest, and these should take the form of more Municipal mehters, more carts and probably more highly paid supervision in the way of a European Inspector who is accustomed to deal with Native labour.

11. In regard to the question of the disposal of solid and liquid filth, I inspected the two trenching grounds and must record that I have never yet come across grounds that were so inoffensive. I am inclined to think that special arrangements were made for my visit as I find from the Municipal records that the night-soil trenches are not always properly covered, but on two occasions I drove along the Beawar Road I did not detect the slightest nuisance from the trenching grounds. The pattern of filth carts is most distinctly good and the method of lifting the bodies out of the cart frames and placing them on the tramway trucks cannot in my opinion be improved upon. There is one point however in which some improvements is required and that at an early date. I refer to the present system of emptying the sullage into tanks at the tramway station and then discharging the tanks into tramway trucks.

I was informed that the bodies of existing sullage carts are too big for the tramway trucks and if that is so, the sooner there bodies are altered or scrapsed the better. I was informed that the nightsoil from the Workshops is decanted into the Municipal trucks at the tamway station because the Railway nightsoil carts are of a special pattern and are required back sooner than the Municipality can give them if they have to be taken out to the trenching ground. This decanting of large quantities of night-soil involves delay and must cause considerable nuisance, but the obvious remedy is of course to have more carts. If the suggestion that I am making in the next paragraph of having the trucks washed daily is acted upon, it will be necessary to considerably increase the number of trucks so as to allow time for washing, drying and petty repairs. The provision of separate trenching grounds for the solids and liquids is a wise one, because it is only when fæces and urine come in contact with each other that the gases of putrefaction are evolved with any rapidity and a nuisance created. In the trenching ground for nightsoil I would recommend for the present that an experiment be made of planting the ground with gourds, melons, castor oil or any other grass feeding leguminous plants. In Bengal excellent crops have been raised on such grounds, but there vegetation flourishes more luxuriantly than in Rajputana. I was informed that attempts had been made to grow lucerne on the sullage ground, that it sprouted well and

then died off. This was due to the manure being too strong. I would suggest that a large slag or cinder bed be constructed close up to the tramway on which the contents of the sullage trucks should be tipped. Slag can I believe be obtained for nothing from the Workshops, and if broken up to the size of a pigeon's egg makes an excellent bacterial filter, the effluents from which produce very fine crops of grass and green fodder. I have explained to the Executive Engineer how these slag beds should be constructed and if some one in the Municipality will only take an intelligent interest in their working I am sure they will be a success ; if however any difficulties arise, I shall be glad to advise furher on the subject.

12. I am informed that many complaints have been made by residents in some of the Railway bungalows of the nuisance caused by the Tramway and Railway Administration have suggested that the Tramway be removed a few 100 yards further off. I believe it is a matter that has been under consideration for some years now, and in view of the recommendations that I shall make later on I think the matter might well be deferred a little longer ; in the meantime however I would recommend that some sidings be laid down at the trenching ground where the trucks could be thoroughly washed after being emptied, as I understand that water is obtainable from a well not far off. The washing-platform would of course have to be paved with stone so as to be impervious and drains would have to be provided in order to run the washings out to the sullage trenching ground. The trucks themselves appeared to me to be of an excellent pattern and if only kept clean the nuisance should be considerably mitigated. It is possible too that a little more supervision in seeing that the trucks are properly closed before they leave the collecting station would help in this direction. The question of having a second collecting station and Tramway and possible another trenching ground to the south of the Railway Workshops was raised in 1905 and duly discussed, but it appears to have been dropped pending decision of the Railway Administration as to whether they would not adopt the septic-tank system for the disposal of the nightsoil and sullage from their workshops. Personally I think it would be an excellent arrangement for everybody concerned if the Railway Administration would adopt this system as it would relieve the Municipality of the disposal of the nightsoil I am told of some 30,000 persons and the latrines in the shops would be much less offensive as the nightsoil and urine would go at once into the septic tanks. This system is being used with much success in all the large mills and factories in and around Calcutta, but of course it can only be adopted when from 4 to 6 gallons of water per head per day are available.

13. If it is found that an independent water-supply for domestic purposes is feasible and practicable then the water of the Foysagar can be utilized for the disposal of nightsoil by the septic-tank system which, as I have said before, is working very well in Calcutta. The system is also to be found at work in Bombay and the United Provinces and I see no reason why it should not be successful here. I should explain that by this system the whole of the offensive putrefactive changes in the nightsoil take place within the tank and that the effluent or discharge from the tank is merely a clear liquid with very little matter in suspension in it. In order to avoid any possible offensiveness this effluent is passed through coke filters before it is discharged into any river or watercourse, but in the case of Indian towns I am of opinion that effluents from septic tanks might be discharged direct into masonry surface drains which in most towns carry off the sullage from the houses—a liquid which is much more offensive than an effluent from a septic tank. In any ordinary town the principle then to be followed is to have a number of these tanks dotted about here and there so that the mehters will have as short a distance as possible to carry the nightsoil. The removal of nightsoil is thus carried out with efficiency and despatch. In the Town ward however, I am afraid it will not be possible, on account of its crowded nature, to follow this principle in its entirely, but every attempt should be made to do so. Public latrines can be conveniently built on the top of septic tanks so that the ground now occupied by large latrines would be available for the septic tanks. In the Suburbs there will be no difficulty in finding suitable sites. By the introduction of this system of sewage disposal coupled with the provision of surface drains for the removal of liquid wastes, the existing Tramway and the two trenching grounds would be abolished. If the Railway Administration could be induced to adopt this system their installation would serve as a training ground for mehters and others who would have to deal with the municipal tanks. I need hardly add that the designs of the septic tanks and filters and the selection of the sites must be entrusted to an expert.

DRAINAGE AND PAVING.

14. I have already indicated that in order to do away with the nuisance of the receptacles for sullage standing out in the streets, it will be necessary to provide some system of surface drains that will carry off the sullage immediately it is produced. On my first drive to the town it appeared to me almost hopeless to think of such a system; but after a more careful examination I am of opinion that it should be perfectly feasible. No detailed scheme

can-be drawn up until a plan of the town on a large scale has been made and levels taken of every street and gully under the control of the Municipality plotted upon it. I would suggest that the plan be drawn to a scale of six feet to the mile and this will prove exceedingly useful to the Municipal Committee in deciding questions of encroachments and boundaries. I do not think it will be necessary at present at any rate to prepare such a plan for the whole of Ajmer, and I would suggest that the area to be dealt with would be that lying between Railway on the east as far as the Railway School on the south and Taragarh and Anasagar on the west and north. When this has been completed, it will then be possible to lay down with accuracy the different drainage areas into which every town is naturally divided. There will be several main drains fed by subsidiary drains, but the natural main outfall is undoubtedly the Bisla tank. If it is decided to convert this tank into a public park, there will be no difficulty in carrying the drainage of the town through it in a covered drain or sewer. In any case some arrangements must be made for utilizing the sullage brought down by the drains as it is a most valuable manure. A good example of the excellent use to which sullage can be put may be seen at Agra, where a sand bank in the Jamna opposite the Fort has been converted into a flourishing vegetable garden. This however is a matter which can be discussed and decided when the detailed plans of the drainage scheme are being worked out. The construction of a complete drainage for the town will no doubt cost several lakhs of rupees before it is fully completed, but there is this distinction between surface drainage works and its twin-sister water-works. In the former, if a complete detailed scheme is formulated in the first instance, the actual construction can be carried on bit by bit as funds become available, with the assurance that in the end each drain will form part of one harmonious whole: in other words the construction can be spread over a long series of years. With water-works, however, the major portion of the works must be constructed forthwith before any benefit accrues. Local bodies cannot in these circumstances ever adopt an attitude of *non possumus* as far as surface drainage schemes are concerned, but they may have some justification for such an attitude in the matter of water-supply.

15. As regards paving, I would recommend that every street and gully in the town be made as impervious as possible because organic matter cannot then soak into the ground and produce offensive smells, and further, because from time to time when sufficient water is available, the streets and gullies can be thoroughly washed down. For streets along which there is wheeled traffic, I would recommend the use of dressed stonesetts,

say 8" × 4" × 7", laid over a bed of 9" concrete. The present system of paving streets with large undressed stones is I consider very objectionable, as the joints are too big, the stones are more or less round and the whole surface is uneven, thus allowing lodging places for filth, *e.g.* droppings of horses, camels, etc. For gullies I would recommend the use of square and dressed stone slabs, say $1\frac{1}{2}''$ to 2" thick, as available, laid on 6" of good concrete, but this work should not be taken in hand until the positions of the drains have been decided for otherwise the slabs will have to be taken up to make a room for the drains. The paving of broad streets however can be taken in hand now as stone setts are easily removed.

16. In connection with the surface drainage scheme I anticipate there will be considerable difficulty with what are undoubtedly encroachments on municipal property that one sees on all sides. Even in Naya Bazar which is a comparatively modern street, *chibutras* have been erected over the drains. There is hardly a street in the town area in which not only one but very many encroachments either of a permanent or temporary character may be seen, and I cannot help thinking that the Municipal Commttee are not exercising their powers under section 86 of Ajmer Municipalities Regulation, 1886, to their fullest extent. The growth of *chibutras* and obstructions in streets is an insidious disease common to all Indian Municipalities, and the only cure is constant watchfulness and a strong determination on the part of the Committee not to allow the property of the people to be encroached upon.

THE ANASAGAR.

17. No Sanitary survey of Ajmer would be complete without some consideration being given to this work which was no doubt intended by the Emperor Shah Jehan to be a thing of beauty. At the present time it is, a dirty shallow pool, offensive both to the eyes and the nose, and if there were many houses round it, I should say a source of ill-health to the inhabitants. The drainage of two valleys is held up by a comparatively short band between two small hills. As the beds of the valleys are comparatively steep and the hills very bare, the result of any considerable rainfall must be a spate or small freshet the waters of which must carry a good deal of matter in suspension or silt. As soon as the flow of water is arrested, the silt is deposited and if it is true that the bed of the tank has never been cleaned out, the silt of centuries must be collected behind the band, or in other words the bed of the tank is being slowly but surely raised with the result that the tank becomes drier and drier as years go on. There are numerous bathing ghats on the south side of the tank but they are all high

and dry now. I would therefore submit for the consideration of the local authorities the following proposal: Let a circular line about a mile in length, or any other length that appears more suitable, be laid out and let a dry rubble masonry stone wall laid along this alignment and carried down to rock level be built, and the silt excavated from the bed of the tank so enclosed to within 1 or 2 feet of the rock bed. The stone wall will act as a retaining wall in preventing the bed of the valley slipping back into the tank, but at the same time will permit all subsoil water to drain into the tank. If money can be found for this, I feel certain that water will always be found in the tank, not of course at any high level in the hot weather, but still there will be water instead of mud as now. A portion of the silt excavated from the tank could be utilized for forming a roadway round the back of the masonry wall; this could be planted with trees and thus be converted into a pleasant and airy drive. Openings would have to be left in the roadway to permit of the passage of the surface rain water. It will be observed that I have said that the silt is to be excavated to within 1 or 2 feet of the rock bed; this is to prevent the rock bed being exposed which would drain off the water in the tank as I understand has happened at Beawar. This scheme no doubt will cost a considerable sum of money, but it is one for which possibly public subscriptions might be called for; and as it is a resuscitation of the former beauties, of the position, possibly the Government of India might be induced to make a grant, seeing that the marble *baradaris* of Shah Jehan have recently been restored at the expense of Government.

18. It only remains for me to throw out some suggestions as to the agency by which my recommendations should be carried out. In regard to the survey of the Sarsuti and Sagarmati Valley beds, it is probable that this can best be done by a temporary subordinate working under the orders of the Executive Engineer. Of course he must have had experience in boring work. In this connection my views are that Government should always bear the cost of experiments in seeking for water, because it so very often happens that the experience gained during these experiments can be made use of by other Municipalities and local bodies from whom no part of the original cost of the experiments would be recoverable. Then, again, if Government bears the cost of the experiments, the amount might be regarded as a gift from Government on account of sanitary works. If the experiments show that there is plenty of water available, I would advise that the water-works scheme be drawn up by an engineer who has had experience in this class of designing, for instance any of the Sanitary Engineers with the Local Governments, because the distribution piping will be rather a difficult matter to arrange on account of the differences in the levels of the different parts of the town. The ordinary

Public Works Department officer has not usually had sufficient experience to undertake this class of work which is altogether a speciality. The preparation of the map of the town and of the surface drainage scheme will be a long and tedious business and will probably take several years. Nagpur, Central Provinces, was surveyed several years ago and the work was I believe in charge of Mr. G. G. White of the Public Works Department, but the preparation of the drainage scheme has been entrusted to Mr. H. H. Lane-Brown of Benares, who makes a speciality of this class of work. Mr. Lane-Brown is only in private practice: it might cause a good deal of inconvenience or even loss to the Municipality should the work be stopped for one cause or another before completion. On the whole I am inclined to recommend that the work be undertaken by the Public Works Department, an independent Sub-division being formed for the purpose and I think an Assistant Engineer of some 5 or 6 years standing should be put in charge. The designing of a surface drainage requires greater powers of application than skill and could probably be done by subordinates once they had been properly instructed. If the map when finished is likely to be of use to Government then a portion of the cost of its preparation should be borne by Government, otherwise the cost must fall on Municipal funds. Similarly the cost of the preparation of the drainage scheme must be borne by the Municipal Committee, although it is quite usual in Bengal for Government to pay a very large proportion of the cost : in fact Government now entertains a staff of surveyors for this purpose alone and their services are given free to the Municipalities. As regards the restoration of the Anasagar, that could be carried out by the Public Works Department provided the necessary funds are forthcoming.

AJMER, A. E. SILK,

The 11th May 1907. *Sanitary Engineer, Bengal.*

APPENDIX C.

NOTE ON THE AJMER WATER-SUPPLY SCHEME.

IN paragraphs 4 to 6 of my Sanitary Survey of Ajmer, dated the 11th May 1907, I explained why it was necessary that we should know something of the levels of the rock underlying the valleys of the Sagarmati and Sarsuti valleys before the site of the experimental pumping well could be decided. So far only the valley of the Sagarmati has been explored in the manner I wished, and I venture to think that the information that has been obtained in this valley fully bears out the opinion expressed by me in paragraph 5 of my Sanitary Survey. The borings were commenced opposite Dumara and carried on to below Misina at both of which places there are spurs running out from the hills, and the longitudinal section attached hereto shows how greatly the depth of the rock-bed below the surface of the valley varies. At Misina a cross-section of the valley was made which shows that there is, as it were, a narrow subterranean gorge, and there can be no doubt that a large quantity of subsoil water must pass through it.

2. I have recently carefully examined the Sagarmati valley between Dumara and Misina, and I am of opinion that the time has now come when a trial well should be sunk in this valley, and I would advise that it be sunk somewhere in the neighbourhood of Pits Nos. 37 and 38. The well should be 6 feet in diameter and should be built of solid masonry throughout, so that water can enter it through the bottom only. The bottom of the well should be kept about 10 feet above the rock-bed so that the subsoil water can have free access to the well. Several kutcha observation wells will be required in order to ascertain the effect of the pumping from the central well on the water level in the surrounding tract. Detailed instructions as to how the whole experiment is to be carried on will be issued separately to the Municipal Engineer. In addition to the above, I think it would be advisable to take two more cross-sections of the Sagarmati valley at Pits Nos. 18 and 24.

3. It must be distinctly understood that the object of an experimental well of the character described in the preceding paragraph is to ascertain only the *number and sizes of the wells that will eventually be required to give the full daily supply of water.* I think it will be quite obvious that it would be quite impossible to ascertain by any experiment whether the ground in which the wells are sunk will continue to give the full daily supply of water over a year or series of years. No direct information on this point is obtainable, and so we must have resort to referential methods based on reasonable assumptions. In hilly countries

with comparatively narrow valleys it is fairly easy to arrive at a rough estimate of the water capacity of the subsoil in which wells are sunk. The only source of the water is rain, and it is quite possible to ascertain without much error the area on which the rain falls. An inch of rain falling on an area of one square mile means that 14½ million gallons of water have to be accounted for. If this quantity fell into an impervious tank on which there was no draft it would gradually disappear by evaporation only. Under natural conditions, however, rain falls on ground of various consistencies e.g., rock, clay, sand, etc., and it depends on the nature of the ground whether the rain water simply flows off on the surface in the form of rivers or whether it soaks into the ground and forms an underground river or whether it does both. In the case of the country round Ajmer the last mentioned condition undoubtedly prevails, and owing to the sandy nature of the ground in the valleys large quantity of water is absorbed and forms an underground river. It is this underground river that we desire to obtain information about and form a rough estimate of its volume. The catchment area of the Sagarmati up as far as Misina has been ascertained to be 90 square miles, and if an inch of rain fell on this area and was absorbed into the ground, a volume of 1,300 million gallons would flow underground past Misina during the year. From the rainfall records of the past 24 years it is found that the annual rainfall at Ajmer has only been less than 10 inches on two occasions viz., 1891 and 1905, and in these years very little water was impounded in the Foy and Ana Sagars and other tanks in the Sagarmati valley. This is easily understood when it is borne in mind that water will not flow over pervious ground until that ground becomes itself saturated or unless the rainfall is very heavy and the slope of the ground very steep. In most years, however, the rainfall is considerably more than 10 inches, and it will thus be seen that if we assume that only one inch of the rainfall in each year is absorbed into the ground or less than 10 per cent., there will be considerably more water available in wells at Misina than will ever be required for the supply of Ajmer.

4. So far I have only considered the Sagarmati valley and had my advice been followed to have both the Sagarmati and Sarsuti valleys sounded I should have been in a position to decide finally from which valley the supply of water for Ajmer should be obtained. During June and July three borings were sunk near the villages of Galti and Vasali, but these borings are at one side of the valley instead of at lowest part of it, and they are consequently of little value in helping me to form an opinion as to the possible position of a pumping station for the supply of water to Ajmer. These bore holes were found to be artesian in charact-

ter; but, as pointed out by me in a demi-official letter, dated the 17th September 1907, to the Commissioner, these conditions could not continue when there was such a heavy draft as 700,000 or 1,000,000 gallons per day, year in and year out, as the catchment area must be so small. This opinion has, I understand, been confirmed by Mr. Vrendenburg, of the Geological Survey of India. In another demi-official letter, dated the 19th November 1907, to the Commissioner, I stated that I did not consider any further borings in the Sarsuti valley necessary, but I find that its catchment area as far as Nand is some 51 square miles, and that being so I have no doubt that wells sunk in this Valley should also give an ample supply of water to Ajmer. Now that boring tools are available and we have at hand workmen experienced in making borings I think the opportunity should not be lost of having this valley surveyed in the same manner as that of the Sagarmati. The information obtained from such a survey will enable me to compare the merits of the two possible sources of water-supply for Ajmer and to form a definite opinion as to which source of supply should be resorted to.

5. The Water-works Committee at their meeting held on the 9th January 1908 asked me to record some information as to the probable cost of the new water-supply scheme and the annual expense of maintaining it in running order. As a first approximate estimate, I am of opinion that it will cost not less than Rs. 10 lakhs to give Ajmer a completely new water-supply system designed on the most modern lines and supplying 1,000,000 gallons per day. I have already given my reasons in my Sanitary Survey of Ajmer for considering that an entirely new system is required for the proper sanitation of the town, and they need not be repeated here. If the whole of this amount has to be borrowed from Government, the annual payments on account of repayment of the loan in 20 years and interest at 4 per cent. (in accordance with the existing orders of the Government of India in regard to loans) will amount to Rs. 73,582. If a smaller sum had to be borrowed the annual payments would, of course, be proportionately smaller; if, for instance, only 6 lakhs had to be borrowed the annual payment would be only Rs. 44,149. In addition to the repayment of the loan and the interest thereon the Municipality will have to provide for annual maintenance charges, repairs, etc. At Haorah, in Bengal, where the water has to be lifted from the river, clarified, filtered and then pumped a distance of 16 miles, these charges amount to 1·1 or 1·2 anna per 1,000 gallons. Steam-driven machinery is used, but for Ajmer I would propose oil engines using crude petroleum to drive the pumps, in which case I am quite sure the annual maintenance charges will not exceed 0·75 anna per 1,000 gallons, or Rs. 17,109 per annum. If then the whole cost of the new water-supply scheme has to be brrrowed

the total amount which the Municipality will have to find annually will be Rs. 73,582 x Rs. 17,109 = 90,691. I must leave it to the local authorities to devise the method of meeting this expenditure, but I think it my duty to point out to them that a pentiful supply of pure water must undoubtedly mean improvement in the health of the community, a greater wage-earning capacity, and that being so, the community is more able to bear increased taxation, either direct or indirect.

AJMER,

The 11th January 1908.

A. E. SILK,

Sanitary Engineer, Bengal.

APPENDIX D.

REPORT ON WELL TEST

IN

THE SAGARMATI VALLEY.

GENERAL.

The Sagarmati River has its sources in the hills surrounding Ajmer and receive the drainage of the whole area coloured red in the plan No. 1 accompanying this report.

Abuot 9 miles from Ajmer in a South-Westerly direction the river passes round the hill spur on which the village of Dumara stands and flows through a wide sandy valley with steep hills on each side towards the village of Bhaonta.

This valley is most fertile and was selected by Mr. Silk Sanitary Engineer Bengal as the most probable place from which an adeqnate supply of water could be obtained for Ajmer.

Borings.

Borings were made along the river bed from Dumara to Mesidhia, to ascertain the strata and the levels of the rock bed of the Valley with cross sections as shown on plan No. 2.

The longitudinal section of the Valley so obtained showed a more or less even slope of rock bed in the direction of the flow of the river until a point nearly opposite the Village of Mesidhia. At this point the rock rises abruptly and forms a natural underground dam which holds up much of the subsoil-water.

The first cross line was from pit No. 16 in a North-Westerly direction to the well of Bhagwan Singh and thence in a North-Easterly direction towards Amba Dhani. From this was obtained the general lie of the rock across the Valley.

In this section it will be seen there is a ridge of rock between Bore holes No. 10 and 13 which themselves show the lowest rock levels on the cross section.

Referring to the plan it is seen that these depressions occur just below the bed of the two nullahs which unite with the main stream near bore hole No. 34. It is therefore probable that these depressions are the original nullah beds.

The second section line was taken between Bore holes No. 34 and 8 and shows the rock level at its lowest part. (The ridge of the rock shown in the logitudinal section continues across the Valley west of this cross section line),

The even level of the water in this cross section also shows that the section has been taken at right angles to flow of the subsoil water.

Site of trial well.

With this data before him Mr. Silk decided that the most advantageous place to sink a trial well would be some where on this line in the neighbourhood of bore holes No. 36 and 37.

The trial well.

The site actually selected was at bore hole No. 37 this being close besides the Ajmer Bhaonta Road which made it easier to carry away the water pumped from the trial well.

The trial well was made six feet diameter of pucca masonry and plastered so as to prevent any water entering except through the bottom. It was intended to sink the well to a depth of 32 feet or 10 feet above the rock level but owing to the tremendous inflow of water it was not possible to sink it more than 26 feet with the appliances available.

From a previous test on the well of Bhagwan Singh (one of the best wells in the Valley) it was found that the maximum rate of in flow was 75 gallons, per square foot, per hour. It was therefore taken that the maximum amount of water to be dealt with in the sinking of the well would be :—

64 square feet, (*ie.* area of excavation) multiplied by 75 or 4800 gallons, per hour. Instead of this a dircharge of over 15,000 gallons, per hour has been found at a depth of only 18 feet.

A large Worthington pump was taken out from Ajmer and a boiler from Budha Pushkar with much trouble owing to there being no proper road after the 8th mile from Ajmer.

The boiler however had not sufficient capacity to allow the Worthington pump to work at full capacity and it was found that about 7000 gallons, per hour was all that could be obtained from this combination.

The failure to get the well down to the prearranged level however in no way effects the results of the test.

The tests were carried out in accordance with instructions received from Mr. Silk, and were made to ascertain the *maximum steady discharge* that could be obtained from the well. The test also shows the effect on the water level in wells in the neighbourhood resulting from constant pumping on the test well. The tests.

The test was carried out in the following manner. Method of testing.

Each day the water surface in the test well was lowered to a prearranged level and by regulating the pumps maintained at that level for about 10 consecutive hours. The water discharged from the well was received in a collecting chamber from which it was allowed to flow in an even stream into a gauge chamber discharging over a triangular notch weir by which the discharge was measured. From the down stream side of the weir the water was conveyed in pipes to a distance from the test well so that none of the water taken from the well should soak back into it.

The discharge was read every hour and the water level in the test well recorded at the same time and averages deduced for each day.

The water level in the observation wells and cultivator's wells in the neighbourhood was noted each day before pumping commenced and when pumping had proceeded for about 5 hours.

At the close of each day's test the time the water in the test well took to rise each 6 inches, was noted.

The following are the tabulated results of the tests.

Table 1 statement of daily average discharge.

Date.	Average head on well.	No. of hours average head was maintained.	Average daily discharge galls. per hour.	Average head in round numbers.	Average discharge in galls. per hour.	Remarks.
27-5-08.	1.5	10	2645	1.5	2599	
28-5-08.	1.5	10	2645			
29-5-08.	1.5	10	2506			
1-6-08.	2	10	3848	2.0	3895	
2-6-08.	2	10	3990			
3-6-08.	2	10	3848			
4-6-08.	2.5	10	5080	2.5	4889	
5-6-08.	2.5	10	4900			
6-6-08.	2.5	10	4752			
7-6-08.	2.5	10	4826			
8-6-08.	3	10	5590	3.0	5659	
9-6-08.	3	10	5680			
10-6-08.	3	10	5590			
11-6-08.	3	10	5775			
12-6-08.	3.5	2*	6138	3.5	6138	* The foot valve of the worthington pump had to be repaired and pumps could not work full time in consequence.
13-6-08.	3.5	8	6138			
14-6-08.	3.5	10	6138			
15-6-08.	3.5	9	6138			
16-6-08.	4.0	5	8300			
17-6-08.	No pumping on this date as steam could not be kept up to supply the Worthington pump.					
	After instructions and personal trials by undersigned the work was continued satisfactorily on 18th.					

Table 1—*Continued.*

Date.	Average head on well.	No. of hours average head was maintained.	Average daily discharge galls. per hour.	Average head in round numbers.	Average discharge in galls. per hour.	Remarks.
18-6-08.	4	9	7970			During this time I was trying to arrange for more power but could not get any until 24th.
19-6-08.	4	9	7970			
20-6-08.	4	7	7860			
21-6-08.	4	8	7970	4	7,997	
22-6-08.	4	9	7970			
23-6-08.	4	10	7970			
24-6-08.	4	10	7970			
25-6-08.	4.5	8	9280	4.5	9,367	
26-6-08.	4.5	10	9,455			
27-6-08.	5	5	10,600	5	10,600	
28-6-08.	5	9	10,600			
29-6-08.	5.5	10	11,130	5.5	11,821	The bottom began to blow slightly.
30-6-08.	5.5	10	12,513			
1-7-08.	6	10	13,243	6.0	13,243	
2-7-08.	6	10	13,243			
3-7-08.	6.5	10	14,462	6.5	14,307	
4-7-08.	6.5	10	14,152			
5-7-08.	7.0	3	15,258			
6-7-08.	7.0	1	15,918	7.0	15,582	
7-7-08.	7.0	10	15,588			Heavy rain testing stopped.

Table 2nd.

Rate of replenishment.

6″ depths rising from lowest level.	Time in minutes.											
	Head. 1·5	Head. 2·0	Head. 2·5	Head. 3·0	Head. 5·5	Head. 4·0	Head. 4·5	Head. 5·0	Head. 5·5	Head. 6·0	Head. 6·5	Head. 7·0
Top 6 inches.	Not recorded.	54	63	129	170	181	190	240	Whole night.	...	...	...
2nd		9	10	14	22	35	67	63	105	134	179	213
3rd		3	3	3	4	$3\frac{1}{2}$	5	$4\frac{1}{4}$	6	12	23	27
4th	...	2	2	2	3	$1\frac{7}{8}$	2	2	2	$3\frac{1}{4}$	$3\frac{3}{4}$	$4\frac{1}{4}$
5th	...	...	1	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	2	2	2
6th	...	...	...	$\frac{1}{2}$	1	1	1	1	$1\frac{1}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$
7th	...	...	...	...	$\frac{1}{4}$	1	1	1	$\frac{3}{4}$	1	1	1
8th	...	...	...	...	...	$\frac{1}{3}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	1
9th	...	...	...	...	...	...	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	1
10th	...	...	...	...	...	...	...	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
11th	...	...	...	...	...	...	...	...	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
12th	...	...	...	...	...	...	...	...	...	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$
13th	...	...	...	...	...	...	...	...	...	...	$\frac{1}{4}$	$\frac{1}{3}$
14th	...	...	...	...	...	...	...	...	...	...	...	$\frac{1}{3}$

Maximum rates of inflow deduced from above table.

Head.	Quantity gallons per hour.
2	2653
2·5	5306
3·0	10612
3·5	21224
4·0	15918
4·5	10612
5·0	10612
5·5	21224
6·0	21224
6·5	21224
7·0	15918

Table 3rd. Level of water in observation wells.

See ferro type attached—

RESULTS OF TESTS.

Table I.

From this table it appears that from a well of 6 feet diameter 10,000 gallons, per hour can be pumped without fear of the bottom of the well being d sturbed by the influx of water. That is that maximum safe head for continuous pumping is 5 feet.

Table 2.

Cannot be depended on to such a degree as after 2·5 feet of head was put on the well the inflow was so rapid that the time had to be taken in fractions of a minute and on the quickness of the observer the results depend. An error of a quarter of a minute which quite easily can creep in, makes a differance of about 10,000 gallons when the reading is between ¼ & ½ a minute. This table is therefore of little use except to prove the rapid flow of the subsoil water.

Table 3.

Which shows the effect of pumping on the subsoil water levels is most important. Taking first the trial well itself from the table it will be seen that on May 27th at the beginning of the test the water level stood at the reduced level of 7·64 and sank to its lowest level 6·97 on the 19th June. That is to say after 21 days pumping during which time 900,000 gallons, of water were pumped, the water level in the well was only reduced 0·67 feet or 8 inches.

The effect of pumping on the observation wells is also shown by table 3.

The nearost well is a cultivator's well No. 12 in the table and is 70 feet, from it only, on the 1st day's pumping with 1·5 feet head this well sank 1·08 feet with 5 feet head it only sank 0·94 which shows that the slope of the subsoil water at this head is very steep. With a 7 feet head it sank even less 0.92.

Next taking the 4 observation wells 200 feet from the well that is No. 1,2,3,4.

The original reduced levels of the water was :—

No. 1	7·11	
No. 2	7·54	
No. 3	7·77	
No. 4	7·56	

The falls due to pumping were with.

Well	Head.			
	1·5	5·0	7·0	
No. 1	0·08	0·08	0·13	
No. 2	0·08	0·09	0·21	
No. 3	0·13	0·08	0·25	
No. 4	0·21	Water rose owing to rain.	0·17	

These figures show that pumping at the test well had very slight effect on these wells 200 feet away.

The reduction in water level in them from the 27th, May to June 19th was :—

No. 1	0·92 =	11 Inches.
No. 2	0·92 =	11 „
No. 3	0·88 =	10½ „
No. 4	0·88 =	10½ „

The next well is :—No. 5—550 feet from the test well.

The effect of pumping on this well was :—

Well.	Head.		
	1·5	5·0	7·0
No. 5 ...	0·04	0·08	0·16

Finally taking the following wells.

	1·5	5·0	7·0
No. 6	0·00	0·00	0·04
No. 7	0·00	0·08	0·08
No. 8	0·00	0·00	0·13
No. 9	0·08	0·00	0·04
No. 10	0 16	0·00	0·08

The total fall in the water between the 27th, May and June 19th was :—

No. 6 ...0·34 = 4″

No. 7 ...0·32 = 4″

„ 8 ... *Nil*	These wells were flooded by the recent rain, but were unaffected by the pumping before the rainfall.
„ 9 ... *Rose*	
„ 10... *Nil*	

From this it appears that only the two wells on the down stream side of the test well have been affected by the pumping and actually while pumping was in progress up to a head of over 5 feet the depression of the water round the test well did not extend to this range of wells, the nearest No. 7 being 700 feet from the test well.

Taking all these figures into consideration it appears that the supply is plentiful and the slope of the subsoil water during pumping steep.

From these results the question of the number and size of wells required will be worked out, and the complete scheme will shortly be ready for final discussion.

These tests have been most satisfactory and from the result it appears that a splendid supply of water is at last available for Ajmer.

A copy of the chemical analysis of the water is given below.

Two samples were sent for analysis one taken directly from the well and one from the discharge of the pump.

No.	Copy of label on bottle.	Total solids grains per gallon.	Chlorine grains per gallon.	Total hardness grains per gallon.	Fixed hardness grains per gallon.	Free ammonia parts per miln.	Albominoid ammonia parts per million.	Nitrites.
1	Water from well.	49	7·5	11·5	5·5	0·01	0·04	Nil.
2	Water pumped from well.	48	7·2	11·5	5·5	0·01	0·03	Nil.

Both of the above water samples are fit for potable purposes.

(Sd.) S. O. HEINEMANN,
Municipal Engineer.

APPENDIX D/1.

APPENDIX—D. 1.

Copy of a D. O. letter Dated 23rd July 1908. from A. E. Silk Esq., Sanitary Engineer, Bengal to S. O. Heinemann, Esq. Municipal Engineer Ajmer.

I have now had an apportunity of studying your report on the pumping experiment in the Sagarmati Valley and I must express my great satisfaction at the careful and intelligent manner in which you have carried out the experiment and at the lucid report you have drawn up. There is just one minor detail that I think might be improved on and that is that you should have drawn out an enlarged plan showing the pumping well and the surrounding observation wells as it is rather difficult to fully appreciate the results without seeing more clearly the relative positions of the wells.

I do not think it would be wise to take a working head of 5 feet because unless the pumps are very carefully and steadily worked, the head will vary and it appears that the bottom of the well begins to blow up with a head of 5·5. The wells themselves will be a very small item in the total cost of the scheme I would therefore recommend that you take the working head to be 2 feet only and if the pumps are kept going continuously throughout the 24 hours, as I think they should be, you will require three wells of 14′ diameter to give you a daily supply of 1,5500,000. The wells should be 200 feet apart with their tops above flood level. The section pipe should be laid at the level of the tops of the wells with the necessary, intermediate supports with this arrangement if a well sinks it will not carry the pipe with it. The section pipe should be of steel. Allow Rs. 1,000 for electric gauges for the wells.

You ought not to have any trouble sinking the wells if you use proper dredgers for with these you need not pump out any water.

APPENDIX E.

Detailed report on the estimate for the works necessary in connection with the improvement of Ajmer water Supply.

Appendix E to the general report.

Data.

The details of this scheme are based on the recommendations of Mr. Silk vide his report on a Sanitary Survey of Ajmer, Appendix B.

The recommendations are :—

1. *Daily Supply.*—Of 10 to 15 gallons per head, allowance being made for increase in population in 30 years.

2. *Supply main.*—Of such capacity as to deliver full supply in 24 hours.

3. *Service Reservoir.*—Of such capacity as to deliver full supply in 6 hours.

4. *Distribution System.*—All pipes to be capable of delivery full supply in 6 hours.

Quantity of water to be supplied.

The quantity of water to be supplied depends on the population.

The population of Ajmer according to the last Census taken in 1901 was in round numbers 74,000 people.

There are no reliable data as to the rate of increase in the population of Ajmer, as since any proper records have been kept the population has been affected by outside causes, such as the erection of the Rajputana Malwa Railway Workshops, and their subsequent enlargement, and again by the ravages of famine in the Ajmer District.

In these circumstances the rate of increase has been estimated on the assumption that the population increases by 10 % per decade.

On this assumption the population of Ajmer will be :—

In 1911	...	...	...	81,400
" 1921	...	...	...	89,540
" 1931	...	...	...	98,494
" 1941	...	...	...	1,08,343

The daily supply therefore on a basis of 10 gallons per head per day, will be:—

1911	...	...	...8,14,000
1921	...	...	...8,95,400
1931	...	...	...9,84,940
1941	...	...	10,83,430
Say	...	...	1,000,000

In addition to this quantity the Railway have asked for an allowance of 3,95,000 gallons per diem and the estimated requirements of certain institutions and private consumers is 2,05,000 gallons bring up the total to 1,6,00000 gallons per diem as the maximum requirements.

This quantity is made up as follows for ready reference. This has been tabulated showing the present and proposed supply.

Table showing present and proposed Water supply.

	Present supply.	Proposed.	Increase.	Remarks.
City or Standpost Supply ...	384,000	1,000,000	616,000	
Railway Workshops	200,000	395,000	195,000	As asked for by the Railway.
Private Consumers	80,000	100,000	20,000	
Mayo College	32,000	35,000	3,000	
Merwara Battalion	10,000	15,000	5,000	The supply is inadequate now.
Jail	2,000	3,000	1,000	"
Government College	not yet opened.	5,000	5,000	Estimate on data supplied by the Committee.
Railway General Office ...	7,000	8,000	1,000	
Balance for extra as required	nil.	39,000	39,000	
	7,15,000	1,600,000	...	

The scheme has been designed on this estimate of a maximum supply of 1,600,000 gallons per diem.

This will not be all required until 1941 and the probable requirements will be as follows :—

1911	...	1,000,000	gallons	per	diem
1921	...	1,200,000	"	"	"
1931	...	1,400,000	"	"	"
1941	...	1,600,000	"	"	"

No scheme would be safe that does not allow for the maximum supply as the present sources of supply have proved unsafe to depend upon. Moreover it is most probable that once this new supply is in working order the Railway will abandon Budha Pushkar and the Foysagar Supply is most precarious.

General remarks on the Scheme.

In the previous report on the results of the tests carried out at Mesedhia in the Sagarmati Valley the general features of the Country and the site of the prposed water works have been commented on and there is no need to go into these again now.

The general features of the proposed scheme is to pump the water from a series of wells sunk at right angles to the direction of the flow of the subsoil water and force it through a rising main into a storage reservoir at Ajmer. From the reservoir the water will be distributed through mains and branches throughout Ajmer.

The heads of the estimate.

The estimate has been divided into the following heads:—

A. Wells.

B. Pump house.

C. Rising main.

D. Service Reservoir.

E. Distribution.

And is dealt with in detail under each head.

A. Wells.

Mr. Silk in his letters dated July 23rd 1908, Appendix D, recommends 3, 14 feet diameter wells, and a working head of 2 feet only.

From the report on the well tests it will be seen a 6 feet diameter well gives 3895 gallons per hour, or 137·77 gallons per Square feet per hour. Therefore 3-14 feet diameter wells will give 63,624·93 gallons per hour.

Mr. Silk has taken 1,500,000 gallons per diem as the maximum supply or 62,500 gallons per hour but with the increased Railway demands 1,600,000 gallons per diem are required or 66,666 gallons per hour therefore 3-14 feet diameter wells are not large enough.

Three 15 feet diameter wells are therefore estimated for.

B. Pump House.

Two alternative estimates have been prepared one for a steam pumping plant and one for pumps driven by oil Engines.

This has been done as there is a certain amount of prejudice against big oil Engine plants.

Leaving out the question of cost at present it would be well to review the advantages and disadvantages of each form of plant.

The advantages of a steam plant are :—

1. The Engines and plant are simple and men are easily obtained to work the plant.

2. The power is directly untilized there being no necessity for gears and shafting.

3. Fuel is obtainable in the country and is not dependent on shipments from other countries.

The disadvantages of steam are.

1. Unless the pumps are working full time a considerable amount of fuel is lost in raising steam, and again when cooling down. This is a serious objection when the cost of fuel is enhanced by about 6 miles of carting.

2. When extra units are required they can not be brought into use quickly, as steam has to be raised first.

3. A large staff of stokers have to be engaged.

The advantages of an oil Engine plant are :—

1. The ease with which they can be started.

2. The quickness with which extra units can be brought into use.

3. No fuel is lost in lighting up, therefore every pound of fuel brought to the pumping Station is used.

4. There is much less dirt and no accumulation of ashes to be disposed of.

5. It is as cheap to work for one hour as twenty four.

The disadvantages are :—

1. The machinery is a little more complicated.

2. The power is not delivered direct but through gears which absorb a certain percentage, of power.

3. The supply of fuel is dependent, at present on countries beyond India and a reserve supply will have to be kept in case of temporary oil famines and high prices.

The difference in cost of the two plants as per estimate is.

	Rs.
Steam...	2,12,490
Oil	2,15,277
Difference in favour of Steam	2,787

The next point is the size of the engines and the number of units.

The maximum quantity of water required is 1,600,000 Gallons per day. This quantity however will not be required until 1941.

The probable consumption at the end of each decade is estimated as :—

1911	... ...	1,000,000 Gallons per day.
1921	... ...	1,200,000 " " "
1931	... ...	1,400,000 " " "
1941	... ...	1,600,000 " " "

That is an increase of 200,000 Gallons per day in every 10 years.

If each pump unit is made to discharge 200,000 Gallons per diem and the present installation made capable of delivering 1,000,000 Gallons per day in Ajmer, it will be easy at the end of each decade to add new duplicate pumps each of 200,000 gallons per day capacity, and the capital expenditure will thus be distributed over 40 years.

In addition all the pumps being of one size, spare parts will be interchangeable, and so a smaller stock will be necessary.

Working on these lines the present requirements will be met with 5 units and one spare unit in case of breakdown.

In 1921 one extra unit will be required another in 1931, and another in 1941 or 9 units in all.

For the steam plant one boiler unit is allowed for two pump units as small boiler units are not so efficient as large ones.

The building is designed for the full number of units as the extra cost will be comparatively small and the difficulty of enlarging the building later will be avoided.

The following quarters will be required :—

Small Inspection Bungalow.
Pump foreman's "
For steam plant.

	now	1921'	31'	41
Fitters quarters	... 7	8	9	11
Menials quarters	...32	32	40	46

For oil plant.

Fitters quarters	... 6	7	8	9
Menials quarters	...12	12	15	15

If oil engines are put in an oil storage tank or tanks will be required. These have been designed to hold 2 months full supply for 6 units, they are themselves divided into 2 units, as a safe guard in case of fire. Another unit will be required say in 1931.

It is proposed to take up 2000 × 1000 feet of land at the pump station to prevent any contamination coming near the wells.

The sanitation of this area is most important and all the quarters have been arranged at the down stream end of the enclosure.

All latrines will be on the water carriage system and will be self flushing. The drainage will be taken away to convenient spot and either discharged into a cesspool which will require constant attention or into a septic tank for bacteriological treatment.

The actual difference in level between the water level in the wells at Sagarmati and the high water level in the service reservoir is 318 feet. C. Rising main.

To this must be added say 12 feet for the total reduction of head during pumping or 330 feet in all.

The total length of main is 12 miles. Taking first 12″ as the diameter of the main the loss of head due to friction in delivering 1,111 Gallons per minute in a distance of 12 miles is 362 feet.

Making the total pumping head *692 feet say 700.*

If an 18″ pipe is taken the head lost by friction is only 51 feet. And the total pumping head will be *381 feet say 400.*

It is therefore better to have an 18″ pipe if the cost is not too great.

A 12″ Cast Iron pipe to stand 700 feet working head works out to cost approximately Rs 600,000 and an 18″ Cast iron pipe would cost approximately Rs. 800,000.

The saving in the cost of pumps by putting in an 18″ pipe is Rs. 105,300.

There will also be a saving in the cost of working by having the larger sized pipe.

With Cast iron pipes it is however questionable whether this saving would be sufficient to make it adviseable to put in an 18″ pipe at an initial capital cost of nearly Rs. 100,000.

With Steel pipes the question takes a different from. The cost of 12″ Steel main as obtained from a quotation of a firm in

Calcutta is approximately Rs. 300,000 and for an 18″ main Rs. 400,000. These are both cheaper than 12″ Cast iron main, and the difference in cost is covered by the saving in the price of the pumping Engines.

It is therefore proposed to lay an 18″ Steal main which will be of ample size to meet all requirments.

D. Service reservoir.

The service reservoir is designed to have a capacity of approximatety 192,000 cubic feet or 1,200,000 Gallons.

That is of sufficient size to allow the whole supply to be delivered in 6 hours.

It is practical square in plan and is divided by a central wall so that either side can be emptied for cleaning without affecting the supply.

The whole is roofed over by a slab and concrete roof carried on Rolled steel beams.

The floor and sides will be cement plastered to prevent leakage.

All sluices are in duplicate.

The sluices are placed in a sluice chamber outside the reservoir in which there is also a stairway leading up to the reservoir.

Ventilators are provided in the reservoir roof to discharge the air when filling and are of the cowl pattern so that dust and dirt can not be blown in.

Quarters are also allowed for the Chaukidars in charge and for 2 line-men.

The site proposed for the reservoir is on the rocky slope North of the Volunteer Rifle range and directly opposite the Mayo College.

The level of the bottom of the reservoir is 100 feet above the weir of the Anasagar lake and commands the whole of Ajmer.

E. The distribution System.

The present distribution system was originally designed for a supply of 350,000 Gallons per diem.

Extentions have since been put in and now the mains cannot carry the supply that is demanded.

The question as to whether the old pipe lines could be utilized in any way in the new scheme has had serious consideration, but for the following reasons it would appear inadviseable to do so.

In the first place the majority of them have been in place for over 20 years and must now be in a very bad state.

The water they have carried has been declared unfit for drinking and even on one occasion to have contained Enteric microbes.

To make any use of these pipes they would have to be taken up cleaned and scraped and redipped in preserving solution.

The new destribution pipes would have to be any how laid to some parts while this work was being done, to carry on the supply, the diameters of the old Mains would not suit the new conditions.

In these circumstances it appears better to leave the present piping in most cases where it is and utilize the supply thus obtained for road watering, drain flushing, etc.

The old hydrants will be removed so that the people cannot take the impure Foysagar water for drinking.

The details of the new distribution system are as follows :—

Ajmer may be divided into two parts the city proper and the suburbs.

According to the last census 52,000 people lived in the city and 22,000 lived in the suburbs.

Up co now the city has been supplied with water free of charge and the small portion of the suburbs that get any water at all has had to pay for it heavily by meter. The settlement along the Srinagar, Nasirabad and Beawar Roads have had no supply at all but pay taxes equally with the more favoured ones in the city.

The city is now becoming congested and all future expansion must be towards these settlements, and a proper water supply to them, is now imperative.

In this scheme therefore ample allowance has been made for these parts.

In building the service reservoir two outlets pipes will be provided. One for a main to supply the Railway direct but which will not be put in until such a time as the demands cannot be met through the other mains.

The other outlet is a 21" Main which will run along the side of the conservancy tramway to a point opposite the Anathala. At this point it will split into two branches one of 18" passing down to the centre of the Kaisergunj seven dials, the other of 14" going straight on to the city proper this line being reduced as required will pass through the Dargah Bazar and continue on to the present supply cisterns.

This is done so that a supply can be given through the Foysagar pipes should the Foysagar supply fail before all pipe lying is finished. Branches will be taken off this main to supply the varivous portions of the city.

The 18″ main after arriving at the Kaisarganj seven dials will split up into two mains one passing long the outside of the city by Madargate and thence on by the Kutchery Road to the Civil Station.

The other will go straight down the Srinagar Road to the Mayo College Gate with branches to the Nasirabad and Beawar Road.

On this main a connection with the Railway Mains will be made for supplying water to them as necessary.

It is proposed to put in these pipes in the order given in the estimate so that the cost may be distributed over some time.

Hydrants will be placed at convenient points as required and fire connections put in all pipes above 2″.

S. O. HEINEMANN,

Municipal Engineer.

APPENDIX F.

General Summary

OF

COST.

Detail Estimate No. A. Wells.

Detail of Work.	No	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
WELLS.										
15 feet diameter.										
Excavation dry ...	...	283·5	×7	...	1,984	6	‰	12	0	0
Do. wet and rock ...	...	283·5	×23	...	6,520	15	"	978	0	0
Pucca masonry ...	...	53·4	2	32	3,417	20	%	685	0	0
Lime plaster outside ...	...	59.69	×32	...	1,910	3	"	57	0	0
Cement plaster inside ...	...	47·12	×32	...	1,508	10	"	150	0	0
Iron curb.										
Iron plates	1	60′	2′	¾″						
Do. do.	2	60′	3′	¾″						
Do. do.	12	3′	2′	¾″	Cwt 153½	30	Cwt.	4,605	0	0
Do. do.	1	55′	2″	¾″						
Bolts	24	1″ dia.	6′	long.						
Iron ladder	...	30	ft.	long.	...	...	...	50	0	0
Manhole cover ...	1	...	...	...	1	30	each	30	0	0
Slab roofing	...	283·5	sft.	...	283·5 sft.	25	%	71	0	0
R. S. Beams	...	12″×	5″×15′	long	4 cwt.	8	Cwt	32	0	0
	...	Rs.	...	...	...	...	Rs.	6,670	0	0
Add for two more ...	...	6,670	×2=	...	...	...	...	13,340	0	0
Total for three wells Rs. ...	...	...	...	...	...	...	...	20,010	0	0
Steel suction pipes 10″ dia...	600	ft. @	21 lbs	per ft.	112½ cwt.	20	Cwt.	2,250	0	0
Sluice valves 10″ " ...	3	...	...	...	3	100	each	300	0	0
Do. do. 5″ " ...	9	...	...	...	9	40	"	360	0	0
Foot do. 10″ " ...	3	...	...	...	3	125	"	375	0	0
Total Rs.. ...	...	...	...	...	...	...	Rs.	3,285	0	0
Well sinking apparatus:—										
Welldredger	3	...	...	...	3	750	each	2,280	0	0
Crab winches... ...	3	...	...	...	3	120	"	360	0	0
Shear legs	2	...	...	...	2	200	"	400	0	0
Electric gauges ...	...	L. S.	...	...	...	...	...	1,000	0	0
							Rs.	4,010	0	0
Total Rs. ...	...	...	..	...	...	...	...	27,305	0	0
Add Contingencies ...	...	@5.	%	...	...	...	...	1,365	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	28,670	0	0

Detail of Estimate No. B 1.

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A	P.
PUMP HOUSE.										
ESTIMATE No. 1 FOR STEAM.										
Excavation.—										
To floor level in pump house.	1	108	34	8	29,376	...	...	...	...	...
In founds of pump house ...	2	108	7	5	7,560	...	...	...	...	...
Do. do. ...	2	20	7	5	1,400	...	...	...	...	...
					8,960					
Founds of pumps ...	9	10	4	5	1,800	...	...	...	...	...
Stair ways	2	13	14	8	2,912	...	...	...	...	...
Boiler house Floor ...	1	48	46	1	2,208	...	...	...	...	...
Office	1	18	21	1	378	...	...	...	...	...
Workshop	I	18	23	1	414	...	...	...	...	...
Stores	1	10	8½	1	85	...	...	...	...	...
Fonnds of walls ...	3	46	6	6	4,968	...	...	...	...	...
Do. do ...	1	88	6	6	3,168	...	...	...	...	...
					8,136					
Store	1	20	4	4	320	...	...	...	...	...
Boiler Founds ...	1	48	33	5	7,920	...	...	...	...	...
Earth Filling	2	26	3	10	1,560	...	...	...	...	...
Do.	2	108	3	10	6,480	...	...	...	...	...
					8,040					
					70,549	5	%o	353	0	0
Concrete.										
In Founds of pump house ...	2	108	7	3	4,536	...	...	...	...	...
Do. do. ...	2	20	7	3	840	...	...	...	...	...
					5,376					
Pnmp Founds... ...	9	10	4	5	1,800	...	...	...	...	...
Stair ways.	2	12	3	3	216	...	...	...	...	...
Do.	2	12	3	4	288	...	...	...	...	...
Do.	2	12	7	3	504	...	...	...	...	...
					1,008					
Crried over ...	...	...	...	...	8,184	...	...	353	0	0

Estimate No. 1 for Steam —(*continued*).

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	8,184	...	...	353	0	0
Boiler house	3	46	6	4	3 312	...	...	...	...	...
Do	1	88	6	4	2,112	...	...	...	...	...
					5,424					
Store	1	20	4	3	240	...	...	...	...	...
Boiler founds	1	44	33	6	8,712	...	...	...		
					22,560	15	%	3,384	0	0
Masonry.										
To ground level ...	2	106	5	2	2,120	...	...	...	...	...
In pump house ...	2	22	5	2	440	...	...	...	...	...
Do. do.	2	104	3	8	4,992	...	...	...	...	...
					5,432					
In Boiler house ...	3	46	3	2	828	...	...	...	...	...
Do. do.	1	84	3	2	504	...	...	...	...	...
					1,332					
Store	1	20	2½	1	50	...	...	...	...	...
In superstructure.—										
Pump house	2	29	2	20	2,320	...	...	...	...	...
Do.	1	26	2	7	364	...	...	...	...	...
Do.	9	3	2	20	1,080	...	...	...	...	...
Do.	9	2	2	20	720	...	...	...	...	...
Do.	13	8	1½	20	3,120	...	...	...	...	...
Do.	5	8	1¼	5	250	...	...	...	...	...
					7,854					
Superstructure ...	3	46	2	20	5,520	...	...	...	...	...
Boiler house etc. ...	2	25	2	7½	750	...	...	...	...	...
Do. do.	1	82	2	20	3,280	...	...	...	...	...
					4,030					
Store	1	20	1½	12	360	...	...	...	...	...
Stair way to pump house ...	2	13	1½	10	390	...	...	...	...	...
					27,088					
Carried over ...	...	...	...	...	27,088	...	...	3,737	0	0

Estimate No. 1 for Steam.—(*continued*).

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	27,088	...	...	3,737	0	0
Deduct for doors & windows	...	..	...	...	2,291	...	...	...	...	...
As per below.—				Net ...	24,797	20	%	4,959	0	0
Do.	5	10	2	10	1,000	...	...	...	...	...
Do.	2½	78	54 ×	2	393	...	...	...	...	...
Do.	13	4	1½	7	546	...	...	...	...	...
Do.	3	5	2	5	150	...	...	...	...	...
Do.	1	8	2	10	160	...	...	...	...	...
Do.	1	4	1½	7	42	...	...	...	..	...
					2,291					
Ashlar stone work ...	21	3	2	2	252	...	...	...	...	...
Under crane	11	2	2	1	44	...	...	...	...	...
Do. trusses ...	19	2	2	1	76	...	...	...	...	...
Do. do.	5	3	2	1	30	...	...	...	...	...
					106					
Under pump	9	10	4	1	360	...	...	...	...	...
Window lintels ...	28	5	2	¾	210	...	..	...	...	...
Do. do.	6	6	2½	¾	68	...	...	...	...	...
					278					
Doors ways	5	12	2	1	120	...	...	...	...	...
Do.	2	10	2	1	40	...	...	...	...	...
Do.	2	5	1½	1	15	...	...	...	...	...
					175					
In string course. ...	..	373	2	1	746	...	...	...	...	...
In arch ways	2½	31½	2	1½	237	...	...	...	...	...
Slabs on steps... ...	26	12	2	$\frac{2}{12}$	52	...	...	...	...	...
Do.	6	20	1	$\frac{2}{12}$	20	...	...	...	...	...
	...	...	...	...	72	...	...	...	...	...
	...	...	...	...	2,270	1	cft.	2,270	0	0
Slab Flooring on 9″ Concrete.										
Do. do. do. ...	1	98	24	...	2,352	...	...	...	...	...
Do. do. do. ...	1	15	48	...	720	...	...	...	...	...
Do. do. do. ...	1	18	23	...	414	...	...	...	...	...
Carried over ...	...	...	...	...	3,486	...	...	10,966	0	0

Estimate No. 1 for Steam—*(continued)*.

Detail of work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	3,486	...	...	10,966	0	0
Slab flooring on 9″ Concrete continued										
Do. do. do. ...	1	18	23	...	444	...	...	...	...	...
Do. do. do. ...	1	10	8½	...	85	...	...	...	...	...
					3,985	...	...	...	...	...
Deduct	9	10	4	...	360					
Total ...	..	...	...	...	3,625	25	%	906	0	0
Coal plat form of rammed Kankar	1	50	50	½	1,250	7	"	88	0	0
Roof										
G. I. sheets 20 B. W. G...	1	105	34	...						
" " " " ...	2	75	34		cwt. 170	14	Cwt.	2,380	0	0
Guttering	2	75	...	...	ft. 150	0-8-0	Ft.	75	0	0
T. Iron 4×4×½ ...	19	28′	@ 12·5	per ft.	lbs. 6,650	...	...	...	...	...
T. Iron 2×2×½ ...	19	14′	@ 5·63	"	1,497	...	...	...	...	...
Bar Iron 1½″ diam. ...	19	24′	@ 5·9	"	2,690	...	...	...	...	...
" " 1″ " ...	19	7′	@ 2·62	"	348	Cwt. ...	...	...	...	...
					11,185=	100101	Cwt.	1,000	0	0
C. I. Pillors	4	@ 18	cwt.	each.	72	10	"	720	0	0
L. Irons parlins 3×3×⅜ ...	...	1,680	ft @	7·03	11,810=	Cwt. 105@10/-	"	1,050	0	0
Terrace roof	1	8½	10	...	85	25	%	21	0	0
R. S. Beams under travelling crane 5″×3″ ...	2	98	× 11lbs.	...	2,156	Cwt. 19@8/-	Cwt.	152	0	0
Doors and windows (as per deductions) ...	5 ×	10 × 10	...	...	500	...	...	...	...	...
" " " ...	25 ×	78 × 54	...	...	196	...	...	...	...	...
" " " ...	13 ×	4 × 7	...	...	364	...	...	...	...	...
" " " ...	3 ×	5 × 5	...	...	75	...	...	...	...	...
" " " ...	1 ×	8 × 10	...	...	80	...	...	...	...	...
" " " ...	1 ×	4 × 7	...	...	28	...	...	...	...	...
Machinery.					1,243	ft. 1/8	Sft.	1,864	0	0
Travelling Crane ...	1	...	...	...	1	1,100	each.	1,100	0	0
Lathe	1	...	...	...	1	550	"	550	0	0
Boring machine ...	1	...	...	...	1	390	"	390	0	0
Shaping machine ...	1	...	...	...	1	825	"	825	0	0
Engine	1	...	...	...	1	600	"	600	0	0
Carried over ...	...	...	...	...	...	...	...	3,455 19,222	0	0

Estimate No. 1 for Steam.—(*continued*).

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs	A.	P.
Brought forward ...	...	...	...	...	...	...	...	19,222	0	0
Brought forward ...	...	...	...	...	...	...	...	3,465	0	0
Various tools and plant ...	L.	S.	...	...	L.	S.	...	1,000	0	0
							Rs.	4,465	0	0
Pumps Boilers etc. at the rate of Rs. 900. per actual water H. P.										
Each unit 17 H. P.=17×900 =Rs. 15,300 ...	...	...	...	...	...	...	...	...	...	...
Required now ...	6	units.	...	...	6	15300	each.	91,800	0	0
C. I. Latrine 3 seats ..	1	...	...	...	1	150	„	150	0	0
Flooring	1	7	10	...	Sft. 70	25	%	17	0	0
Stoneware trough with flushing tank etc. ...	1	...	...	...	1	200	each.	200	0	0
							Rs.	92,167	0	0
								1,15,854	0	0
Add contingencies @ 5 % ...	...	...	...	...	...	...	...	5793	0	0
Grand Total. ...	...	...	...	...	...	...	...	1,21,647	0	0
ABSTRACT OF THE FOREGOING.										
Expenditure to be incurred at once.										
Pump house buildings ...	...	...	...	...	...	...	...	19,222	0	0
Machinery	...	...	...	...	...	...	...	4,465		
Pumps and Boilers etc. ...	...	...	...	...	...	...	...	92,167	0	0
							Rs.	1,15,854	0	0
Add contingencies @ 5% ...	...	...	...	...	...	...	...	5,793	0	0
Grand Total ...	...	...	...	...	...	...	...	1,21,647	0	0
ESTIMATE OF :—										
EXPENDITURE TO BE INCURRED IN FUTURE YEARS IS ENCLOSED.										
Expenditure to be incurred in 1921.										
Abstract of Pumps & Boilers etc., at the rate of Rs. 900 per actual water H. P. Each unit 17 H. P.=17×90=Rs. 15,300.										
Required	1	...	...	...	...	15,300	Unit.	15,300	0	0
Add Contingencies @ 5/%	...	...	...	...	...	...	...	715	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	16,065	0	0

Estimate No. 1 for Steam.—(*continued*).

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount Rs.	A.	P.
Expenditure to be incurred in 1931.										
Abstract of Pumps & Boilers etc., at the rate of Rs. 900 per actual water H. P. Each unit 17 H. P. = 17 × 900 = Rs. 15,300.										
Required	1	...	...	...	1	15,300	Unit.	15,300	0	0
Add Contingencies @ 5/ %	...	...	...	...	...	...	...	765	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	16,065	0	0
Expenditure to be incurred in 1941.										
Abstract of Pump & Boilers etc., at the rate of Rs. 900 per actual water H. P. Each unit 17 H. P. = 17 × 900 = 15,300										
Required	1	...	...	...	1	15,300	Unit.	15,330	0	0
Add contingencies @ 5/ %	...	...	...	...	...	...	...	765	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	16,065	0	0
Staff Quarters.										
Inspection Bungalow.										
Excavation of Founds ...	2	25	4	3	1,320	...	...	...	...	...
Do. do. ...	4	13	4	3	624	...	...	...	...	...
Do. do. ...	1	71	4	3	852	...	...	...	...	...
Do. do. ...	8	55	3½	3	5,77½	...	...	...	...	...
Do. do. ...	4	4½	3½	3	198	...	...	...	...	...
Do. do. ...	2	4½	3	3	81	...	...	...	...	...
Do. do. ...	2	17	4	3	408	...	...	...	...	...
					4,051	5	‰	20	0	0
Concrete in founds ...	2	55	4	2	880	...	...	...	...	...
Do. do. ...	2	13	4	2	208	...	...	...	...	...
Do. do. ...	1	71	4	2	568	...	...	...	...	...
Do. do. ...	1	55	3½	2	385	...	...	...	...	...
Do. do. ...	1	4½	3½	2	31	...	...	...	...	...
Carried over Rs. ...	...	...	...	...	2,072	...	...	20	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	2,072	...	...	20	0	0
Concrete in founds ...	2	$4\frac{1}{2}$	3	2	54	...	...	...	...	...
Do. do. ...	2	17	2	2	272	...	...	...	...	...
					2,398	12	%	288	0	0
Pucca masonry ...	2	54	3	1	324	...	...	...	...	...
Do. do.	2	14	3	1	84	...	...	...	...	...
Do. do.	1	69	3	1	207	...	...	...	...	...
Do. do.	1	54	$2\frac{1}{2}$	1	135	...	...	...	...	...
Do. do.	4	$5\frac{1}{2}$	$2\frac{1}{2}$	1	55	...	...	...	...	...
Do. do.	2	$5\frac{1}{2}$	2	1	22	...	...	...	...	...
Do. do.	2	17	3	1	102	...	...	...	...	...
Do. do.	2	53	2	18	3,816	...	...	...	...	...
Do. do.	4	15	2	18	2,160	...	...	...	...	...
Do. do.	2	19	$1\frac{1}{2}$	13	741	...	...	...	...	...
Do. do.	4	$6\frac{1}{2}$	$1\frac{1}{2}$	13	507	...	...	...	...	...
Do. do.	2	$6\frac{1}{2}$	1	13	169	...	...	...	...	...
Do. do.	16	2	2	7	448	...	...	...	...	...
Do. do.	1	69	2	$4\frac{1}{2}$	621	...	...	...	...	...
Do. do.	2	23	2	$4\frac{1}{2}$	414	...	...	...	...	...
Do. do.	1	15	$1\frac{1}{2}$	$4\frac{1}{2}$	101	...	...	...	...	...
					9,906	...	...	...	...	...
Deduct doors and windows...	10	4	2	7	560	...	...	...	...	...
" " " ...	2	3	2	7	84	...	...	...	...	...
" " " ...	4	3	$1\frac{1}{2}$	7	126	...	...	...	...	...
" " " ...	2	2	$1\frac{1}{2}$	3	18	...	...	...	...	...
" " " ...	12	3	2	2	144	...	...	...	...	...
					932					
					8,974	18	%	1,615	0	0
Stone Work.										
Brackets	12	4	2	1	96	...	...	...	...	...
Do.	4	3	3	1	36	...	...	...	...	...
Crrried over ...	...	...	...	...	132	...	...	1,923	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	132	...	...	1,923	0	0
Sunshades	14	4	3	$\frac{1}{4}$	42	...	...	...	...	...
Verandah slabs ...	16	8	2	$\frac{3}{4}$	192	...	...	...	...	...
Lintels	10	6	2	$\frac{1}{2}$	60	...	...	...	...	...
Do.	2	5	2	$\frac{1}{2}$	10	...	...	...	...	...
					436					
Lintels	4	5	$1\frac{1}{2}$	$\frac{1}{2}$	15	...	...	...	...	...
Do.	2	4	$1\frac{1}{2}$	$\frac{1}{2}$	6	...	...	...	...	...
Do.	12	5	2	$\frac{1}{2}$	60	...	...	...	...	...
Chimney Slabs ...	3	3	2	$\frac{1}{4}$	5	...	...	...	...	...
Cornice	...	336	2	$\frac{3}{4}$	504	...	...	...	...	...
					1,026	1	ft.	1,026	0	0
Terrace roof	1	51	17	...	867	...	...	...	...	...
Do. do.	1	67	7	...	469	...	...	...	...	...
Do. do.	2	18	7	...	252	...	...	...	...	...
Do. do.	...	51	7	...	357	...	...	...	...	...
					1,945	25	%	486	0	0
Slab flooring on 9″ concrete.	3	15	15	...	675	...	...	...	...	...
Do. do. do. ...	4	$7\frac{1}{2}$	$7\frac{1}{2}$	...	225	...	...	...	...	...
Do. do. do. ...	1	15	8	...	120	...	...	...	...	...
Do. do. do. ...	1	69	8	...	552	...	...	...	...	...
Do. do. do. ...	2	17	8	...	272	...	...	...	...	...
					1,844	25	%	461	0	0
R. S. Beams	...	15 ft.	@	20 lbs.	9 cwt.	8	cwt.	72	0	0
Doors & windows as per deductions ...	10	4	7	...	280	...	...	...	...	...
Do. do. do. ...	2	3	7	...	42	...	...	...	...	...
Do. do. do ...	4	3	7	...	84	...	...	...	...	...
Do. do. do ...	2	2	3	...	12	...	...	...	...	...
Do. do. do. ...	12	3	2	...	72	...	...	...	...	...
					490	1-8-0	Ft.	735	0	0
Closets including flushing tanks etc ...	2	...	...	...	2	80	each.	160	0	0
Carried over ...	...	...	...	...	...	...	...	4,863	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	4,863	0	0
Cook House.										
Excavation	2	24	3½	2	336	...	...	...	...	...
"	3	10	3½	2	210	...	...	...	...	...
					546	5	‰	3	0	0
Concrete as excavation ...	2	24	3½	2	336	...	...	...	...	...
" " ...	3	10	3½	2	210	...	...	...	...	...
					546	12	%	65	0	0
Pucca masonry ...	2	15	1½	14	630	...	...	...	...	...
" "	2	10	1½	14	420	...	...	...	...	...
" "	1	10	3	4	120	...	...	...	...	...
" "	3	1½	1½	8	54	...	...	...	...	...
					1,224					
Deduct doors and windows,	1	3	1½	7	31	...	...	...	...	...
" "	1	3	1½	4	18	...	...	...	...	...
					49					
					1,175	18	%	212	0	0
Terrace roof	1	10	12	...	120	...	...	...	...	...
" "	1	12	8	...	96	...	...	...	...	...
					216	25	%	54	0	0
Slab floor	1	10	12	...	120	...	...	...	...	...
" "	1	12	8	...	96	...	...	...	...	...
					216	...	...	...	...	...
Stone work	1	3	4	¼	3	25	%	54	0	0
"	2	5	1½	1½	7	...	...	...	...	...
"	2	12	1½	1	36	...	...	...	...	...
					46	1	foot.	46	0	0
Doors and windows ...	1	7	3	...	21	...	...	...	...	...
" " ...	1	4	3	...	12	...	...	...	...	...
					33	1-4-0	foot.	41	0	0
								475	0	0
Carried over ...	...	...	...	...	...	...	...	5,338	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	5,338	0	0
SERVANTS QUARTERS.										
One Quarter.										
Excavation	3	10	$3\frac{1}{2}$	2	210	...	...	...	...	...
"	1	17	$3\frac{1}{2}$	2	119	...	...	...	...	.
					329	5	%	2	0	0
Concrete as above ...	3 1	10 17	$3\frac{1}{2}$ $3\frac{1}{2}$	2 2	329	12	%	39	0	0
Pucca masonry ...	2	10	$1\frac{1}{2}$	15	450	...	...	...	...	...
" "	1	15	$1\frac{1}{2}$	15	337	...	...	...	...	...
" "	1	$1\frac{1}{2}$	$1\frac{1}{2}$	8	18	...	...	...	...	...
					805					
Deduct doors and windows...	1	7	3	$1\frac{1}{2}$	31	...	...	...	...	...
" " ..	1	4	3	$1\frac{1}{2}$	18	...	...	...	...	...
					49					
				Net	756	18	%	136	0	0
Terrace roof	1	12	10	...	120	...	...	...	...	...
" "	1	10	8	...	80		...	...	...	...
					200	25	%	50	0	0
Slab floor	1	12	10	...	120	...	...	...	...	...
" "	1	10	8	...	80	...	...	...	...	...
					200	25	%	50	0	0
Doors and windows ...	1	7	3	...	21	...	...	...	...	...
" " ...	1	4	3	...	12	...	...	...	...	...
					33	1-4-0	ft.	41	0	0
Stone work	1	12	$1\frac{1}{2}$	1	18	...	...	...	...	...
" "	2	5	$1\frac{1}{2}$	$\frac{1}{2}$	7	...	...	...	...	...
" "	1	4	3	$\frac{1}{4}$	3	...	...	...	...	...
					28	1	ft.	28	0	0
								Rs. 346	0	0
								" 4	0	0
Add for 4 more ...	...	...	...	...	...	...	...	" 1,384	0	0
								" 1,730	0	0
Carried over ...	...	...	...	...	...	...	...	7,068	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	7,068	0	0
Stable and coach house.										
One stable.										
Excavation	1	23½	3½	2	164	...	...	...	...	...
„	2	12	3½	2	168	...	...	...	...	...
					332	5	°/oo	2	0	0
Concrete as above ...	1 2	23½ 12	3½ 3½	2 2	332	12	°/o	40	0	0
Pucca masonry ...	1	22½	1½	15	506	...	...	...	...	...
„ „	2	12	1½	15	540	...	...	...	...	...
					1,046					
Deduct opening ...	1	8	1½	9	108	...	...	...	...	...
				Net	938	18	°/o	169	0	0
Roof	1	20	12	...	240	25	„	60	0	0
Kanker floor	1	20	... 12	...	240	2-8-0	„	7	0	0
							Rs.	278	0	0
Add for one more ...	...	...	...	...	...	...	„	278	0	0
Total ...		...	...	...	...	...	...	556	0	0
Coach House										
Excavation	2	23½	3½	4	658	...	...	...	...	...
„	2	12	3½	2	168	...	...	...	...	...
					826	5	°/oo	4	0	0
Concrete as above ...	2 2	23½ 12	3½ 3½	4 2	826	12	°/o	99	0	0
Pucca masonry ...	2	22½	1½	15	1,012	...	...	...	...	...
„ „	2	12	1½	15	540	...	...	...	...	...
					1,552					
Deduct opening ...	1	10	1½	9	135		...	...	...	...
				Net	1,417	18	°/o	254	0	0
Roof	1	20	12	...	240	25	„	60	0	0
Slab floor	1	20	12	...	240	25	„	60	0	0
							Rs.	477	0	0
One seated Latrine complete	1	...	...	...	1	170	...	170	0	0
							Rs.	8,271	0	0
Add contingencies @ 5 °/o ...							...	414	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	8,685	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Steam Pumps House Estimate Continued.										
Quarters.										
Inspector's Bungalow.										
Excavations of founds ...	2	55	4	3	1,320	...	...	...	...	...
Do. do. ...	4	13	4	3	624	...	...	...	...	...
Do. do. ...	1	71	4	3	852	...	...	...	...	...
Do. do. ...	1	55	3½	3	577½	...	...	...	...	...
Do. do. ...	4	4½	3½	3	189	...	...	...	...	...
Do. do. ...	2	4½	3	3	81	...	...	...	..	...
Do. do. ...	2	17	4	3	408	...	...	...	...	...
					4,051	5°/₀₀	20-0-0	...	...	...
Deduct.										
Excavation of founds ...	3	15	4	3	540	...	...	...	...	...
Do. do. ...	1	15	3½	3	257	...	...	...	...	...
					697	5°/₀₀	3-0-0			
				Net.	3,354	5°/₀₀	17-0-0	17	0	0
Concrete in founds ...	2	55	4	2	880	...	...	...	...	...
Do. do. ...	2	13	4	2	208	...	...	...	...	...
Do. do ...	1	71	4	2	568	...	...	...	...	...
Do. do. ...	1	55	3½	2	385	...	...	...	...	...
Do. do. ...	1	4½	3½	2	31	...	...	...	...	...
Do. do. ...	2	4½	3	2	54	...	...	...	...	...
Do. do. ...	2	17	4	2	272	...	...	...	...	...
					2,398	12 %	228-0-0	...	...	...
Deduct										
Concrete	3	15	4	2	360	...	...	...	...	...
Do.	1	15	3½	2	105	...	...	...	...	...
					465	12°/₀	56			
					1,933	12°/₀	232	232	0	0
Pucca masonry ...	2	54	3	1	324	...	...	...	...	...
Do. do. ...	2	14	3	1	84	...	...	...	...	...
Do. do. ...	1	69	3	1	207	...	...	...	...	...
Carried over. ...	...	...	...	...	615	...	...	249	0	0

Detail of work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	..	...	...	...	615	...	...	249	0	0
Pucca masonry ...	1	54	2½	1	135	...	...	...	...	...
Do. do. ...	4	5½	2½	1	55	...	...	...	...	...
Do. do. ...	2	5½	2	1	22	...	...	...	...	...
Do. do. ...	2	17	3	1	102	..	...	...	...	...
Do. do. ...	2	53	2	18	3,816	...	...	...	...	...
Do. do ...	4	15	2	18	2,160	...	...	...	...	...
Do. do. ...	2	19	1½	13	741	...	...	...	...	...
Do. do. ...	4	6½	1½	13	507	...	...	...	...	...
Do. do. ...	2	6½	1	13	169	...	...	...	...	...
Do. do. ...	16	2	2	7	448	...	...	...	...	...
Do. do ...	1	69	2	4½	621	...	...	...	...	...
Do. do. ...	2	23	2	4½	414	...	...	...	...	...
Do. do. ...	1	15	1½	4½	101	...	...	...	...	...
					9,906					
Deduct doors and windows.	10	4	2	7	560	...	...	...	...	...
" " " ...	2	3	2	7	84	...	...	...	...	...
" " " ...	4	3	1½	7	126	...	...	...	...	...
" " " ...	2	2	1½	3	18	...	...	...	...	...
" " " ...	12	3	2	2	144	...	...	...	...	...
					932					
					8,974	18%	1615/	...	...	...
Deduct.										
Pucca Masonry ...	3	15	3	1	135	...	...	...	...	...
" " ...	1	15	2½	1	37	...	...	...	...	...
" " ...	2	15	2	18	1,080	...	...	...	...	...
" " ...	3	2	2	8	96	...	...	...	...	...
" " ...	1	7½	1½	13	146	...	...	...	...	...
" " ...	1	15	2	4	120	...	...	...	...	...
" " ...	1	15	1½	4	90	...	...	...	...	...
" " ...	1	15	2	18	540	...	...	...	...	...
Carried over ...	...	...	...	...	2,244	...	...	...	...	...
Carried over ...	...	...	...	...	8,974	...	1,615	249	0	0

Detail of work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	..	...	...	...	615	...	...	249	0	0
Pucca masonry ...	1	54	2½	1	135	...	...	...	...	...
Do. do. ...	4	5½	2½	1	55	...	...	...	...	...
Do. do. ...	2	5½	2	1	22	...	...	...	...	...
Do. do. ...	2	17	3	1	102	..	...	...	...	...
Do. do. ...	2	53	2	18	3,816	...	...	...	...	...
Do. do ...	4	15	2	18	2,160	...	...	...	...	...
Do. do. ...	2	19	1½	13	741	...	...	...	...	...
Do. do. ...	4	6½	1½	13	507	...	...	...	...	...
Do. do. ...	2	6½	1	13	169	...	...	...	...	...
Do. do. ...	16	2	2	7	448	...	...	...	...	...
Do. do ...	1	69	2	4½	621	...	...	...	...	...
Do. do. ...	2	23	2	4½	414	...	...	...	...	...
Do. do. ...	1	15	1½	4½	101	...	...	...	...	...
					9,906					
Deduct doors and windows.	10	4	2	7	560	...	...	...	...	...
" " " ...	2	3	2	7	84	...	...	...	...	...
" " " ...	4	3	1½	7	126	...	...	...	...	...
" " " ...	2	2	1½	3	18	...	...	...	...	...
" " " ...	12	3	2	2	144	...	...	...	...	...
					932					
					8,974	18°/₀	1615	...	...	...
Deduct.										
Pucca Masonry ...	3	15	3	1	135	...	...	...	...	...
" " ...	1	15	2½	1	37	...	...	...	...	...
" " ...	2	15	2	18	1,080	...	...	...	...	...
" " ...	3	2	2	8	96	...	...	...	...	...
" " ...	1	7½	1½	13	146	...	...	...	...	...
" " ...	1	15	2	4	120	...	...	...	...	...
" " ...	1	15	1½	4	90	...	...	...	...	...
" " ...	1	15	2	18	540	...	...	...	...	...
Carried over ...	...	...	...	...	2,244	...	...	...	...	...
Carried over ...	...	...	...	...	8,974	...	1,615	249	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs	A.	P.
Brought forward ...	...	...	...	...	8,974	...	1,615	249	0	0
Brought forward ...	...	...	...	...	2,244	...	...	...	...	...
Deduct doors & windows ...	5	7	5	2	350	...	...	...	...	...
" " " ...	4	4	2	2	64	...	...	...	...	...
					414					
					1,830	18 %	329	...	...	...
			Net.		7,144	18 %	1,286	1,286	0	0
Stone work.										
Brackets ...	12	4	2	1	96	...	...	...	...	...
" ...	4	3	3	1	36	...	...	...	...	...
Sunshades ...	14	4	3	¼	42	...	...	...	...	...
Verandah slabs ...	16	8	2	¾	192	...	...	...	...	...
Lintels ...	10	6	2	½	60	...	...	...	...	...
Do. ...	2	5	2	½	10	...	...	...	...	...
Do. ...	4	5	1½	½	15	...	...	...	...	...
Do. ...	2	4	1½	½	6	...	...	...	...	...
Do. ...	12	5	2	½	60	...	...	...	...	...
Chimney slabs ...	3	3	2	¼	5	...	...	...	...	...
Cornice ...	...	336	2	¾	504	...	...	...	...	...
					1,026	1ft.	1,026			
Deduct.										
Stone work ...	3	4	2	1	24	...	...	...	...	...
Do. ...	4	8	2	¾	48	...	...	...	...	...
Do. ...	4	4	3	¼	12	...	...	...	...	...
Do. ...	5	6	2	½	30	...	...	...	...	...
Do. ...	4	15	2	¾	90	...	...	...	...	...
					204	1 ft.	204	...	...	...
			Net.		822	1 ft.	822	822	0	0
Terrace roof ...	1	51	17	...	867	...	...	...	...	...
Do. do. ...	1	67	7	...	469	...	...	...	...	...
Do. do. ...	2	18	7	...	252	...	...	...	...	...
Do. do. ...	1	51	7	...	357	...	...	...	...	...
					1,945	25 %	486	...	...	...
Carried over ...	...	...	...	...	1,945	...	486	2,357	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount Rs.	A.	P.
Brought forward ...	...	...	...	...	1,945	...	486	2,357	0	0
Deduct.										
Terrace roof ...	1	15	15	...	225	...	...	...	...	...
Do. do. ...	2	15	8	...	240	...	...	...	...	...
					465	25%	116			
			Net.		1,480	25%	370	370	0	0
Slab flooring on 9" Concrete.	3	15	15	...	675	...	...	...	...	...
Do. do.	4	7½	7½	...	225	...	...	...	...	...
Do. do.	1	15	8	...	120	...	...	...	...	...
Do. do.	1	69	8	...	552	...	...	..	...	...
Do. do.	2	17	8	...	272	...	...	...	...	...
					1,844	25%	461			
Deduct.	1	15	15	...	225	...	...	...	...	...
Slab floor ...	2	15	8	...	240	...	...	...	...	...
" " ...					465	25%	116	...	...	...
			Net.		1,379	25%	345	345	0	0
R S. Beams 8' × 4" ...	...	31 ft.	lbs. @20 =	lbs. (1,020)	cwt. 9	8/cwt.	72	...	...	...
Deduct.										
R. S. Beam ...	...	17 ft.	lbs. @20=	lbs. (340)	cwt. 3	8/cwt.	25	...	...	...
			Net.		cwt. 6	8/cwt.	47	47	0	0
Doors and windows as per deduction ...	10	4	7	...	280	...	...	...	...	...
Do. do. ...	2	3	7	...	42	...	...	...	...	...
Do. do. ...	4	3	7	...	84	...	...	...	...	...
Do. do. ..	2	2	3	...	12	...	...	...	...	...
Do. do. ...	12	3	2	...	72	...	...	...	...	...
					490	1-8-0	foot.	735	0	0
Closets including flushing tanks etc ...	2	...	...	...	2	80/	each	160	0	0
Carried over ...	...	...	...	...	...	...	...	4,014	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	4,114	0	0
Cook House.										
Excavation	2	24	3½	2	336	...	...	...	...	...
Do	3	10	3½	2	210	...	...	...	...	...
					546	5	°/oo	3	0	0
Concrete as excavation ...	2	24	3½	2	336	...	...	...	...	...
" " ...	3	10	3½	2	210	...	...	...	..	...
					546	12	%	65	0	0
Pucca Masonry ...	2	15	1½	14	630	...	...	...	...	...
Do. do. ...	2	10	1½	14	420	...	...	...	...	...
Do. do. ...	1	10	3	4	120	...	...	...	.	...
Do. do. ...	3	1½	1½	8	54	...	...	...	...	...
					1,224					
Deduct doors and windows	1	3	1½	7	31	...	...	...	...	...
Do. do. do. ...	1	3	1½	4	18	...	...	...	...	...
					49					
					1,175	18	%	212	0	0
Terrace roof	1	10	12	...	120	...	...	...	...	...
" "	1	12	8	...	96	...	...	...	...	...
					216	25	%	54	0	0
Slab floor	1	10	12	...	110	...	...	...	...	...
" "	1	12	8	...	96	...	...	...	...	...
					216	25	%	54	0	0
Stone work	1	3	4	¼	3	...	...	...	...	...
" "	2	5	1½	½	7	...	...	...	...	...
" "	2	12	1½	1	36	...	...	...	...	...
					46	1	foot.	46	0	0
Doors and windows ...	1	7	3	...	21	...	...	...	...	...
" " " ...	1	4	3	...	12	...	...	...	...	..
					33	1-4-0	foot.	41	0	0
							Rs.	475	0	0
Carried over ...	...	...	...	...	...	...	...	4,489	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	4,489	0	0
SERVANT QUARTERS. *One Quarter.*										
Excavation	3	10	3½	2	210	...	...	...	...	...
"	1	17	3½	2	119	...	...	...	...	...
					329	5	‰	2	0	0
Concrete as above ...	3	10	3½	2	210	...	...	...	...	...
" " ...	1	17	3½	2	119	...	...	...	...	...
					329	12	%	39	0	0
Pucca Masonry ...	2	10	1½	15	450	...	...	...	...	...
" "	1	15	1½	15	337	...	...	...	...	...
" "	1	1½	1½	8	18	...	...	...	...	...
					805					
Deduct doors and windows	1	7	3	1½	31	...	...	...	...	...
" " ...	1	4	3	1½	18	...	...	...	...	...
					49	...	...	...	...	...
				Net.	756	18	%	136	0	0
Terrace roof	1	12	10	...	120	...	...	...	...	...
" "	1	10	8	...	80	...	...	...	...	...
					200	25	%	50	0	0
Slab floor	1	12	10	...	120	...	...	...	...	...
"	1	10	8	...	80	...	...	...	...	...
					200	25	%	50	0	0
Doors and windows ...	1	7	3	...	21	...	...	...	...	...
" " ...	1	4	3	...	12	...	...	...	...	...
					33	1-4-0	ft	41	0	0
Stone work	1	12	1½	1	18	...	...	...	...	...
"	2	5	1½	½	7	...	...	...	...	...
...	1	4	3	¼	3	...	...	...	...	...
					28	1	ft.	28	0	0
								346 ×3	0 0	0 0
Add for 3 more ...	...	...	...	...	...	...	...	1,038	0	0
								1,384	0	0
Carried over ...	...	...	...	...	...			5,873	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...								5,873	0	0
STABLE AND COACH HOUSE.										
One stable.										
Excavation	1	23½	3½	2	164	...	...	...	...	...
"	2	12	3½	2	168	...	...	...	...	...
					332	5	0/100	2	0	0
Concrete as above ...	1	23½	3½	2	164	...	...	...	...	...
"	2	12	3½	2	168	...	...	...	...	...
					332	12	%	40	0	0
Pucca masonry ...	1	22½	1½	15	506	...	...	...	...	...
"	2	12	1½	15	540	...	...	...	...	...
					1,046	...	...	...	...	...
Deduct Opening ...	1	8	1½	9	108	...	...	...	...	...
				Net	938	18	%	169	0	0
Roof	1	20	12	...	240	25	"	60	0	0
Kankar floor	1	20	12	...	240	2-8-0	"	7	0	0
							Rs...	278	0	0
COACH HOUSE.										
Excavation	2	23½	3½	2	658	...	...	...	...	...
"	2	12	3½	2	168	...	...	...	...	...
					826	5	%	4	0	0
Concrete as above ...	2	23½	3½	2	658	...	...	...	...	...
"	2	12	3½	2	168	...	...	...	...	...
					826	12	%	99	0	0
Pucca masonry ...	2	22½	1½	15	1,012	...	...	...	...	...
"	2	12	1½	15	540	...	...	...	...	...
					1,552					
Deduct Opening ...	1	10	1½	9	135	...	...	...	...	...
				Net	1,417	18	%	254	0	0
Road	1	20	12	...	240	25	"	60	0	0
Slab floor... ...	1	20	12	...	240	25	"	60	0	0
One seated latrine complete.	1	...	...	...	1	170	"	170	0	0
								6,798	0	0
Add contingencies @5 %	...	...	...	...	...	...	...	340	0	0
Grand Total Rs.	...	...	...	...	...	...	...	7,138	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Fitters Quarters.										
End Quarter.										
Excavation	2	40	3½	2	560	...	...	...	...	...
Do.	4	21½	3½	2	602	...	...	...	...	...
Do.	1	12	3½	2	84	...	...	...	...	...
Do.	1	15	2	1	30	...	...	...	...	...
					1,276	5	°/oo	6	0	0
Concrete as above ...	2	40	3½	2	560	...	...	...	...	...
" " " ...	4	21½	3½	2	602	...	...	...	...	...
" " " ...	1	12	3½	2	84	...	...	...	...	...
" " " ...	1	15	2	1	30	...	...	...	...	...
					1,276	12	%	153	0	0
Pucca Masonry ...	3	15	1½	15	1,012	...	...	...	...	...
" "	2	6½	1½	10	195	...	...	...	...	...
" "	2	16½	1½	8	396	...	...	...	...	...
" "	2	20	1½	15	900	...	...	...	...	...
" "	1	21½	1½	8	258	...	...	...	...	...
" "	1	1½	1½	10	22	...	...	...	...	...
" "	1	14	1¼	8	140	...	...	...	...	...
					2,923	...	...	...	...	...
Deduct	4	7	3	1½	126	...	...	...	...	...
"	2	4	3	1½	36	...	...	...	...	...
					162	...	...	...	...	...
				Net	2,761	18	%	497	0	0
Stone work	4	5	1½	½	15	...	...	...	...	...
Do.	2	12	1½	1	36	...	...	...	...	...
Do.	2	5	3	¼	7	...	...	...	...	...
Do.	2	5	1½	½	7	...	...	...	...	...
					65	1	ft.	65	0	0
Doors and windows ...	4	7	3	...	84	...	...	...	...	...
" " ...	2	4	3	...	24	...	...	...	...	...
					108	1-4-0	ft.	135	0	0
Carried over ...	...	...	...	...	...	...	...	586	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	856	0	0
Terrace Roof	1	22	13	...	286	...	...	...	...	...
Do. " ...	1	22	8	...	176	...	...	...	...	...
					462	25	%	116	0	0
Slab floor	1	20	12	...	240	...	...	...	...	...
Do.	1	20	8	...	160	...	...	...	...	...
Do.	1	2	6	...	36	...	...	...	...	...
					436	25	%	109	0	0
C. I. Sheets ...	1 ...	8 ...	$4\frac{1}{2}$ ...	... ...	36 2cwt.	14	Cwt.	28	0	0
Kanker flooring ...	1	22	15	...	330	7	%	23	0	0
Latrine ficture ...	...	...	...	...	...	L. S.	...	70	0	0
End quarter Total Rs. ...	...	...	...	...	...	...	...	1,202	0	0
Centre Quarter.										
Excavation	2	40	$3\frac{1}{2}$	2	560	...	...	...	...	...
"	4	$21\frac{1}{2}$	$3\frac{1}{2}$	2	602	...	...	...	...	...
"	1	12	$3\frac{1}{2}$	2	84	...	...	...	...	...
"	1	15	2	1	30	...	...	...	...	...
					1,276	...	...	...	...	...
Deduct.										
Excavation	1	40	$3\frac{1}{2}$	2	280	...	...	...	...	...
					996	5	‰	5	0	0
Concrete as above ...	2	40	$3\frac{1}{2}$	2	560	...	...	...	...	...
" " ...	4	$21\frac{1}{2}$	$3\frac{1}{2}$	2	602	...	...	...	...	...
" " ...	1	12	$3\frac{1}{2}$	2	84	...	...	...	...	...
" " ...	1	15	2	1	30	...	...	...	...	...
Deduct.					1,276					
Concrete	1	40	$3\frac{1}{2}$	2	280	...	...	...	...	...
					996	12	%	120	0	0
Pucca masonry ...	3	15	$1\frac{1}{2}$	15	1,012	...	...	...	...	...
Do. do.	2	$6\frac{1}{2}$	$1\frac{1}{2}$	10	195	...	...	...	...	...
Do. do.	2	$16\frac{1}{2}$	$1\frac{1}{2}$	8	396	...	...	...	...	...
Carried over ...	...	...	...	...	1,603	...	...	1250	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	1,603	...	...	125	0	0
Pucca Masonry ...	2	20	1½	15	900	...	...	...	...	...
Do. do.	1	21½	1½	8	258	...	..	...	...	...
Do. do.	1	1½	1½	10	22	..	...	...	...	...
Do. do.	1	14	1¼	8	140	...	...	...	...	...
					2,923					
Deduct	4	7	3	1½	126	...	...	...	...	...
Do.	2	4	3	1½	36	...	...	...	...	...
					162					
Deduct.					2,761					
Pucca masonry ...	1	15	1½	15	337	...	...	...	...	...
Do. do.	1	6½	1½	10	97	...	...	...	...	...
Do. do.	1	16½	1½	8	198	...	...	...	...	...
			Net		632					
				Net	2,129	18	%	383	0	0
Stone work	4	5	1½	½	15	...		...	...	...
Do. do.	2	12	1½	1	36	...	...	...	...	...
Do. do.	2	5	3	¼	7	...	...	...	...	...
Do. do.	2	5	1½	¼	7	...	...	...	...	...
					65	1	ft.	65	0	0
Doors and windows ...	4	7	3	...	84	...	...	...	...	...
Do. do.	2	4	3	...	24	...	...	...	...	...
					108	1-4-0	ft.	135	0	0
Terrace roof	1	22	13	...	286	...	...	...	...	...
Do. do.	1	22	8	...	176	...	...	...	...	...
					462	25-0-0	%	116	0	0
Slab floor	1	20	12	...	240	...	...	...	...	...
Do. do.	1	20	8	...	160	...	...	...	...	...
Do. do.	1	9	6	...	36	...	...	...	...	...
					436	25-0-0	...	109	0	0
G. I. Sheets	1	8	4½	...	36 = 2 cwt.	14	cwt.	28	0	0
Kanker flooring ...	1	22	15	...	330	7-0-0	%	23	0	0
Carried over ...	...	...	...	...	...	...	...	984	0	0

Detail of work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brougth forward ...	...	...	...	...	...	...	...	984	0	0
Latrine ficture ...	...	...	...	...	...	L. S.	...	70	0	0
Total Centre quarter Rs. ...	...	...	...	...	...	...	...	1,054	0	0
Wanted now for steam pump house.										
Centre quarter... ...	6	...	...	...	6	1,054	Unit.	6,324	0	0
End quarter	1	...	...	...	1	1,202	"	1,202	0	0
								7,526	0	0
Add contingencies @ 5 per cent	...	...	...	...	...	..	...	376	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	7902	0	0
Estimate of expenditure to be incurred in future years is enclosed.—										
Expenditure to be incurred in 1921.										
Centre quarter ...	1	...	...	...	1	1,054	Unit.	1,054	0	0
Add Contingencies@ 5%	...	...	...	...	...	...	...	53	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	1,107	0	0
Expenditure to be incurred in 1931.										
Centre quarter ...	1	...	...	...	1	1,054	Unit.	1,054	0	0
Add Contingencies@ 5%	...	...	...	...	...	...	...	53	0	0
Grand Total Rs. ...	...	...	...	...	...	..	...	1,107	0	0
Expenditure to be incurred in 1941.										
Centre quarters ...	2	...	...	...	2	1,054	Unit.	2,108	0	0
Add Contingencies @ 5 %	...	...	...	...	...	...	...	106	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	2,214	0	0
Menial's Quarter.										
Centre Quarter.										
Excavation	3	10	3½	2	210	...	...	...	...	...
Do.	1	7	3½	2	119	...	...	...	...	...
					329	5	‰	2	0	0
Carried over ...	...	...	...	...	...	...	...	2	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	2	0	0
Concrete	3	10	3½	2	210	...	...	...	...	...
Do.	1	17	3½	2	119	...	...	...	...	...
					329					
Add. Concrete ...	1	17	3½	2	119	...	...	...	...	...
					448					
Pucca Masonry ...	2	10	1½	15	450	...	...	...	...	...
" "	1	15	1½	15	337	...	...	...	...	...
" "	1	1½	1½	8	18	...	...	...	...	...
					805					
Deduct doors and windows.	1	7	3	1½	31	...	...	...	...	...
" " " ...	1	4	3	1½	18	...	...	...	...	...
					49					
					756					
Add. Pucca Masonry ...	1	15	1½	15	337	...	...	...	...	...
Do. do. ...	1	1½	1½	8	18	...	...	...	...	...
					1,111	18	%	200	0	0
Terrace Roof	1	12	10	...	120	...	...	...	...	...
" "	1	10	8	...	80	...	...	...	...	...
					200	25	%	50	0	0
Slab floor	1	12	10	...	120	...	...	...	...	...
" "	1	10	8	...	80	...	...	...	...	...
					200	25	%	50	0	0
Stone work	1	12	1½	...	18	...	...	...	...	...
" "	2	5	1½	½	7	...	...	...	...	...
" "	1	4	3	¼	3	...	...	...	...	...
					28	1	ft.	28	0	0
Doors and windows ...	1	7	3	...	21	...	...	...	...	...
" " ...	1	4	3	...	12	...	...	...	...	...
					33	1-4-0	ft.	41	0	0
Total End quarter ...	...	...	...	...	...	...	...	425	0	0

Detail of Estimate No. B. 2.

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
ALTERNATIVE ESTIMATE FOR PUMP HOUSE WITH OIL ENGINE.										
Pump house.										
Excavation.—										
To floor level	1	173	54	8	74,736	...	...	...	...	...
Infounds.—										
Do.	2	173	7	4	9,688	...	...	...	...	...
Do.	2	40	7	4	2,240	...	..	...	...	...
Do.	10	6	6	4	1,440	...	...	...	...	...
Do.	2	15	4	4	480	...	...	...	...	...
Do.	1	41	4	4	656	...	...	...	...	...
Do.	2	14	16	7	3,136	...	...	...	...	...
Do.	1	12	3	4	144	...	...	...	...	...
Do.	9	14	7	4	3,528	...	...	...	...	...
Do.	9	8	7	4	2,016	...	...	...	...	...
					98,064	5	°/oo	490	0	0
Earth filling	2	173	3	8	8,304	...	...	...	...	...
" "	2	40	3	8	1,920	...	...	...	...	...
					10,224	4	°/oo	41	0	0
Concrete	2	173	7	3	7,266	...	...	...	...	...
"	2	40	7	3	1,680	...	...	...	...	...
"	10	6	6	3	1,080	...	...	...	...	...
"	2	15	4	3	360	...	...	...	...	...
"	1	41	4	3	492	...	...	...	...	...
"	4	14	4	3	672	...	...	...	...	...
"	4	14	5	2	560	...	...	...	...	...
"	1	12	3	3	108	...	...	...	...	...
"	9	14	7	4	3,528	...	...	...	...	...
"	9	8	7	4	2,016	...	...	...	...	...
Pucca Masonry.					17,762	15	°/o	2,664	0	0
To floor level	42	4	5	2	1,680	...	...	...	...	...
" "	2	52	5	2	1,040	...	...	...	...	...
" "	10	4	4	2	320	...	...	...	...	...
Carried over ...	...	...	...	...	3,040	...	...	3,195	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Por.	Amount Rs.	A.	P.
Brought forward ...	...	...	...	...	3,040	...	...	3,195	0	0
To floor Level	44	3½	4½	2	1,386	...	...	...	..	...
To first off set... ...	42	2	3	3½	882	...	...	...	...	...
" "	2	50	3	3½	1,050	...	...	...	...	...
" "	44	5½	2½	3½	2,117	...	...	...	...	...
To ground level ...	42	2	2½	3½	735	...	...	...	...	...
" "	2	49	2½	3½	857	...	...	...	...	...
" "	44	5½	2	4½	2,178	...	...	...	...	...
To roof	42	2	2	17	2,856	...	...	...	..	...
"	2	48	2	17	3,264	...	...	...	...	...
"	44	5½	1½	16	5,808	...	...	...	...	...
"	1	163	2	23	7,498	...	...	...	...	...
"	4	13	1½	20	1,560	...	...	...	...	...
"	1	13	1½	13	253	...	...	...	...	...
"	1	13	1¼	13	211	...	...	...	..	...
"	1	48	1½	13	936	...	...	...	...	...
"	1	15	1½	13	292	...	...	...	...	...
"	2	12	4	3	288	...	...	...	...	...
"	2	163	1¼	1	407	...	...	..	...	...
"	3	48	1¼	1	180	...	...	...	...	...
"	2	13	1¼	1	32	...	...	...	...	...
"	1	40	1¼	1	50	...	...	...	...	...
Deduct.					35,880					
Arches	11	13	2	10	2,860	...	...	...	...	...
"	5½	area. 132	73	2	1.460	...	...	...	..	...
Opening above ...	22	5½	2	3	726	...	...	...	...	...
Arches at stair ways ...	2	10	2	6	240	...	...	...	...	...
" " " ...	1	78	area. 54	2	157	...	...	...	...	...
Do. smithy ...	2	8	1½	5½	132	...	...	...	...	...
Do. do. ...	1	50	area. 26	1½	75	...	...	...	...	...
Do. do. ...	2	10	1½	5½	165	...	...	...	...	...
Do. do. ...	1	78	area. 54	1½	117	...	...	...	...	...
Carried over ...	...	...	...	..	5,932	...	...	3,195	0	0
Carried over ...	...	...	...	...	35,880	...	...	...	...	...

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	35,880	...	...	3,195	0	0
Brought forward ...	...	...	...	...	5,932	...	...	...	...	...
Door to store ...	1	7	6	1½	63	...	...	...	...	...
Windows	44	4	7	1½	1,848	...	...	...	...	...
"	2	4	7	2	112	...	...	...	...	...
"	4	4	2	2	64	...	...	...	...	...
For rail brackets ...	2	163	1½	2	978	...	...	...	...	...
" "	1	163	2	2	652	...	...	...	...	...
					9,649					
				Net	26,231	20	%	5,246	0	0
Doors and windows.										
Doors	2	10	6	...	120	...	...	...	...	...
"	1	...	78·54	...	78	...	...	...	...	..
"	1	7	4	...	28	...	...	...	...	..
Windows	44	6	4	...	1,056	...	..	...	...	...
"	4	4	2	...	32	...	...	...	...	...
					1,314	1 8	foot.	1,971	0	0
Stone Work.										
Bed stones	9	14	9	1	1,134	...	...	...	...	...
"	9	7	6	1	378	...	...	...	...	...
Brackets	2	163	2	2	1,304	...	...	...	...	...
"	1	163	4	2	1,304	...	...	...	...	...
Under girders ...	63	2	2	¾	189	...	...	...	...	...
String course	2	167	2¾	1	918	...	...	...	...	...
" "	2	48	2¾	1	264	...	...	...	.	...
Lintels	46	5½	1½	½	189	...	...	...	...	...
"	1	6	1½	½	4	...	...	...	...	...
"	4	6	1½	½	18	...	...	...	...	...
Sills	46	5½	2	¾	379	...	...	...	...	...
Sunshades	46	5	5½	¼	316	...	...	...	...	...
"	4	3	5	¼	15	...	...	...	...	...
Arch work	5½	41	2	1½	676	...	...	...	...	...
"	2	31·5	2	1½	189	...	...	...	...	...
Carried over. ...	...	...	...	...	7,277	...	...	10,412	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	7,277	...	...	10,412	0	0
Arch work	1	25	1½	1½	56	...	...	...	...	...
					7,333	1	Ft.	7,333	0	0
Terrace roof	1	165	46	...	7,590	...	...	...	...	...
" "	1	46	13	...	598	...	...	...	...	...
" "	1	13	13	...	169	...	...	...	...	...
					8,357	25	%	2,089	0	0
Slab flooring	1	163	44	...	7,172	...	...	...	...	...
" "	1	20	12	...	240	...	...	...	...	...
" "	1	10	12	...	120	...	...	...	...	...
" "	2	12	12	...	288	...	...	...	...	...
					7,820	...	...	...	...	...
Deduct	9	13	9	...	1,053	...	...	...	...	...
"	9	7	6	...	378	...	...	...	...	...
"	10	2	2	...	40	...	...	...	...	...
					1,471					
				Net	6,349	25	%	1,587	0	0
R. S. beams 15" × 5"@42 lbs per foot	21	46=	966×	feet. 42=	40,872 / 112	= 8' 362¼	Cwt.	2,898	0	0
R. S. beams 12" × 6"@44 lbs per foot	2	15=	30×	feet. 44=	1320=12 / 112	8	"	96	0	0
Storage tanks for oil.										
C. I. Tanks	4	245	...	...	980	10	Cwt.	9,800	0	0
Foundations										
Excavation	2	41	33	6	16,236	5	‰	80	0	0
Concrete	2	41	33	3	8,118	15	%	1,217	0	0
Masonry	4	40	2	2	640	...	...	...	...	...
"	4	26	2	2	416	...	...	...	...	...
"	4	40	1½	2	480	...	...	...	...	...
"	4	26	1½	2	312	...	...	...	...	...
"	6	25	2	6	1,800	...	...	...	...	...
					3,648	20	%	729	0	0
Carried over ...	...	...	...	...				36,241	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward.	...	...	...	...	...	...	...	35,241	0	0
Machinery.										
Machinery as per estimate No. B. 1 for steam power.	...	...	...	...	...	...	...	4,465	0	0
Pumps Boilers etc.										
Pumps Boilers etc. as per estimate No. B. 1 for steam power ...	...	...	...	...	...	...	...	92,167	0	0
							Rs.	1,32,873	0	0
Add contingencies at 5 % ...	...	...	...	...	...	...	...	6,643	0	0
Grand total Rs. ...	...	..	...	...	...	...	...	1,39,516	0	0
Abstract of the foregoing.										
Expenditure to be incurred at once.										
Pump house buildings ...	..	...	...	...	...	...	...	36,241	0	0
Machinery	...	...	...	...	...	...	...	4,465	0	0
Pumps and boilers etc. ...	...	...	...	...	...	...	...	92,197	0	0
								1,32,873	0	0
Add contingencies @ 5 %	...	...	...	...	...	...	...	6,643	0	0
Grand total Rs. ...	...	...	...	...	...	...	...	1,39,516	0	0
Estimate of expenditure to be incurred in future years is enclosed.										
Expenditure to be incurred in future years same as per steam engine estimate No. B. 1.										
Pumps and Boilers &c.										
In 1921	...	...	...	...	...	...	...	16,065	0	0
In 1931	...	...	...	...	...	...	...	16,065	0	0
In 1941	...	...	...	...	...	...	...	16,065	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	48,195	0	0
OIL ENGINE. Estimate for staff quarters *Staff Quarters.*										
Inspection Bungalow as per Estimate No. B 1 ...	...	...	...	...	...	...	...	8,685	0	0
Inspector's Bungalow as per Estimate No. B I ...	...	...	...	...	...	...	...	7,138	0	0
Carried over ...	...	...	...	...	...	...	...	15,823	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	15,823	0	0
Fitters quarters details as per Estimate No. B. 1.										
End quarter	1	...	...	...	1	1,202	each	1,202	0	0
Add Contingencies @ 5 %	...	...	...	...	...	...	...	60	0	0
	...	...	...	...	...	...	Rs.	1,262	0	0
Centre quarter ...	5	...	...	...	5	1,054	each	5,270	0	0
Add Contingencies @ 5 %	...	...	...	...	...	...	...	263	0	0
							Rs.	5,533	0	0
Total Rs. ...	...	...	...	...	...	...	...	6,795	0	0
Menials quarters details as per Estimate No. B. 1										
End quarter	1	...	...	...	1	425	each	425	0	0
Add Contingencies @ 5 %	...	...	...	...	...	...	...	21	0	0
	...	...	...	...	...	...	...	446	0	0
Centre quarters ...	11	...	...	...	11	347	each	3,817	0	0
Add Contingencies @ 5 %	...	...	...	...	...	...	...	191	0	0
							Rs.	4,008	0	0
Total Rs. ...								4,454	0	0
Latrine 12 seats ...	1	...	...	...	1	1,000	each	1,000	0	0
Roadways drains etc. as per details in estimate no B. 1.	...	...	...	...	...	...	...	5,885	0	0
Total ...							Rs.	6,885	0	0
Add contingencies @ 5. %	...	...	...	...	...	...	"	345	0	0
Total ...							"	7,230	0	0
Grand Total Staff quarters...	...	...	...	...	...	...	"	34,302	0	0
EXPENDITURE TO BE INCURRED IN FUTURE YEARS IS ENCLOSED.										
IN 1921.										
Filter's Quarters.										
Centre quarter ...	1	...	...	...	1	1,107	each	1,107	0	0
Carried over ...	...	...	...	...	...	...	...	1,107	0	0

Detail of work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	..	...	...	...	...	...	...	1,107	0	0
In 1931.										
Fitter's quarters.										
Centre quarter	1	...	...	...	1	1,107	each.	1,107	0	0
In 1911										
Fitter's quarters.										
Centre quarter	1	...	...	...	1	1,107	each.	1,107	0	0
In 1931.								3,321	0	0
Menial quarters.										
Centre quarter	3	...	...	...	3	347	each.	1,041	0	0
Add contingencies @ 5% ...	...	...	...	...	...	...	...	52	0	0
							Rs.	1,093	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	4,414	0	0

Detail Of Estimate No. C.

Detail of Work.	No.	Measurement. L.	Measurement. B.	Measurement. H.	Quantity	Rate.	Per.	Amount. Rs.	A.	P.
Rising main.										
18" Lap Welded steel pipes including Railway Freight.	...	...	...	...	...	...	...	3,37,125	0	0
Special valves etc. ...	...	...	...	...	...	...	...	62,875	0	0
							Rs.	4,00,000	0	0
Laying 12 miles 18" pipes	...	ft. 63,360	...	...	ft. 63,360	21	%	13,306	0	0
							Rs.	4,13,306	0	0
Add contingencies @ 5%	...	...	...	...	...	...	...	20,665	0	0
Total Estimate Rs. ...	...	...	...	...	...	...	...	4,33,971	0	0

Detail of Estimate No. D.

Detail of Work.	No	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
SERVICE RESERVOIR.										
Excavation in rock and soil.										
Down and floor level ...	1	156	154	7	1,68,168	...	...	...	...	...
Do. do.	1	78	20	2	3,120	...	...	...	...	...
					1,71,288					
Excavation in founds ...	2	156	8	4	9,984	...	...	...	...	...
Do. do. ...	2	140	8	4	8,960	...	...	...	...	...
Do. do. ...	1	140	11	4	6,160	...	...	...	...	...
Do. do. ...	1	140	127	2	35,560	...	...	...	...	...
					60,664					
Addition under piers ...	204	4	4	2	6,528	...	...	...	...	...
In Sluice Chamber ...	2	78	4	2	1,248	...	...	...	...	...
Do. do. ...	4	20	4	2	640	...	...	...	...	...
Do. do. ...	4	10	3	2	240	...	...	...	...	...
Do. do. ...	4	10	8	1	320	...	...	...	...	...
Do. do. ...	1	24	10	1	240	...	...	...	...	...
Do. do. ...	1	78	2	1	156	...	...	...	...	...
					2,844					
					2,41,324	15	°/oo	3,620	0	0
Concrete	2	156	8	4	9,984	...	...	...	...	...
Do.	2	140	8	4	8,960	...	...	...	...	...
Do.	1	140	11	4	6,160	...	...	...	...	...
Do.	1	140	127	2	35,560	...	...	...	...	...
Do.	204	4	4	2	6,528	...	...	...	...	...
Do.	2	78	4	2	1,248	...	...	...	...	...
Do.	4	10	3	2	240	...	...	...	...	...
					68,680	15	°/o	10,302	0	0
Pucca masonry ...	2	154	6	2	3,696	...	...	...	...	...
Do. do. ...	2	153	5½	2	3,366	...	...	...	...	...
Do. do. ...	2	152	5	2	3,040	...	...	...	...	...
Do. do. ...	2	151	4½	2	2,718	...	...	...	...	...
Do. do. ...	2	150	4	2	2,400	...	...	...	...	...
Carried over	...	...	...	...	15,223	...	...	13,922	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	15,220	...	...	13,922	0	0
Pucca Masonry ...	2	148	3	2	1,776	...	...	...	...	...
Do. do. ...	2	140	5	10	1,4000	...	...	...	...	...
Do. do. ...	2	140	3	2	1,680	...	...	...	...	...
Do. do. ...	1	142	6	9	7,668	...	...	...	...	...
Do. do. ...	1	142	2	1½	426	...	...	...	...	...
Do. do. ...	204	4	4	10	32,640	...	...	...	...	...
Do. do. ...	1	77	2	12	1,848	...	...	...	...	...
Do. do. ...	1	30	2	12	720	...	...	...	...	...
Do. do. ...	4	20	2	12	1,920	...	...	...	...	...
Do. do. ...	4	12	1½	12	864	...	...	...	...	...
Do. do. ...	2	2	1½	8	48	...	...	...	...	...
Do. do. ...	2	30	1½	10	900	...	...	...	...	...
Do. do. ...	2	24½	1½	10	735	...	...	...	...	...
Do. do. ...	2	2	1½	8	48	...	...	...	...	...
					80,493					
Deduct doors and windows...	6	7	3	2	252	...	...	...	...	...
Do. do. do. ...	1	8	5	2	80	...	...	...	...	...
Do. do. do. ...	2	4	5	2	80	...	...	...	...	...
Do. do. do. ...	3	4	5	1½	90	...	...	...	...	...
Do. do. do. ...	1	7	3	1½	31	...	...	...	...	...
					533					
Opening under stair ...	2	5	4	1½	60	...	...	...	...	...
					593					
					79,900	20	%	15,980	0	0
Stone work.										
Caps to piers	216	2	2	½	432	...	...	...	...	...
Lintels and Sills ...	6	5	2	½	30	...	...	...	...	...
Do. do. ...	1	7	2	½	7	...	...	...	...	...
Do. do. ...	2	6	2	½	12	...	...	...	...	...
Do. do. ...	3	6	1½	½	13	...	...	...	...	...
Carried over ...	...	...	...	...	62	...	...	29,902	0	0

Detail of Work.	No.	Measurement. L.	Measurement. B.	Measurement. H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ..	...	...	...	...	62	...	...	2,9902	0	0
Lintels and Sills ...	1	5	1½	½	4	...	...	...	...	...
Do. do.	2	6½	1½	½	10	...	...	...	...	...
					76					
Slab beams	2	9	2	1	36	...	...	...	...	...
Do. do.	2	8	2	1	32	...	...	...	...	...
Do. do.	2	6½	1½	1	19	...	...	...	...	...
					87					
Sun shades	6	5	4¼	...	30	...	...	...	...	...
Brackets	12	3	3	¼	27	...	...	...	...	..
Do.	8	2	1	½	8	...	...	...	...	...
					35					
Steps	14	6	1	⅛	10	...	...	...	...	...
Do.	12	3	1	⅛	4	...	...	...	...	...
					14					
					674	1	foot.	674	0	0
Terrace roofing.										
Over Reservoir ...	1	141	142	...	20,448	...	...	...	...	...
Do. do.	1	28	20	...	560	...	...	...	...	...
Do. do.	1	76	6	...	456	...	...	...	...	..
Do. do.	2	23	16	...	736	...	...	...	...	...
	...	...	...	...	22,200	25	%	5,550	0	0
Slab flooring	1	26	12	...	312	...	...	...	...	...
Do. do.	4	10	12	...	480	...	...	...	...	...
Do. do.	1	7	6	...	42	...	...	...	...	...
					834	25	%	209	0	0
Cement plaster ...	1	142	140	...	19,880	...	...	...	...	...
Do. do.	4	142	11	...	6,248	...	...	...	...	...
Do. do.	2	140	11	...	3,080	...	...	...	...	...
Do. ... do.	204	8	11	...	17,952	...	...	...	...	...
					47,160	10	%	4,716	0	0
Carried over ...	...	...	..	...	...	...	...	41,051	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	41,051	0	0
Lime plaster fine ...	2	20	20	...	800	...	...	...	...	...
Do. do.	2	26	20	...	1,040	...	...	...	...	...
Do. do.	2	2	8	...	32	...	...	...	...	...
					1,872	4	%	75	0	0
Doors	7	7	3	...	147	...	...	...		...
Do.	1	8	5	...	40	...	...	...	...	...
Do.	5	4	5	...	100	...	...	...	...	...
					272	1-8-0	foot	430	0	0
R. S. Beams 8′ × 4″ ...	@	18	lbs.	per	foot.	...	...	...	...	...
Do.	238 ×	101 =	2,380	× 18		...	...	...	...	...
Do.	=	$\frac{42846}{112}$	lbs.	=	Cwt. 382½	8	Cwt.	3,060	0	0
ditto 12″ × 5″ ...	@	32	lbs.	per.	foot.	...	...	...	...	...
	60	feet ×	$\frac{1920}{112}$	lbs.	Cwt. 17	8	...	136	0	0
Total Rs. ...	...	...	...	...	...	...	...	44,752	0	0
Add Contingencies ...	...	...	...	...	@	5	%	2,237	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	4,6051	0	0

Detail of Estimate No. E.

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Expenditure to be incurred at once.										
Distribution System city piping.					Cwt.					
21" C. I Pipes ...	155	...	...	...	3,051	...	...	...	...	...
18" " " ...	135	...	...	...	2,187	...	...	...	...	...
14" " " ...	220	...	...	...	2,485	...	...	...	...	...
13" " " ...	170	...	...	...	1,711	...	...	...	...	...
12" " " ...	100	...	...	...	833	...	...	...	...	...
10" " " ...	90	...	...	...	433	...	...	...	...	...
9" " " ...	700	...	...	...	2,950	...	...	...	...	...
6" " " ...	200	...	...	...	475	...	...	...	...	...
5" " " ...	450	...	...	...	900	...	...	...	...	...
4" " " ...	1300	...	...	...	1,950	...	...	...	...	...
3" " " ...	800	...	...	...	900	...	...	...	...	...
2½" " " ...	750	...	...	...	717	...	...	...	...	...
2" " " ...	1050	...	...	...	430	...	...	...	...	...
					19,081					
Add 5 % Specials. ...	...	...	...	...	954	...	...	...	...	...
					20,035	7-8-0	Cwt.	15,0,262	0	0
Laying pipes.										
21" ...	...	1,860	...	...	...	24	%	446	0	0
18" ...	...	1,620	...	...	...	21	"	340	0	0
14" ...	...	2,640	...	...	...	18	"	475	0	0
13" ...	...	2,040	...	...	...	16	"	326	0	0
12" ...	...	1,200	...	...	...	14	"	168	0	0
10" ...	...	810	...	...	...	12	"	97	0	0
9" ...	...	6,300	...	...	...	12	"	756	0	0
6" ...	...	1,800	...	...	...	9	"	162	0	0
5" ...	...	4,050	...	...	...	8	"	324	0	0
4" ...	...	11,700	...	...	...	6	"	702	0	0
3" ...	...	7,200	...	...	...	5	"	360	0	0
2½" ...	...	6,750	...	...	...	4	"	270	0	0
2" ...	...	9,450	...	...	...	4	"	378	0	0
Carried over ...	...	...	...	...	...	...	...	4,864	0	0
								1,55,066	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	1,55,066	0	0
Sluice Valves.										
21" ...	...	...	...	...	2	375	Each.	750	0	0
18" ...	...	...	...	...	1	310	"	310	0	0
14" ...	...	...	...	...	1	185	"	185	0	0
13" ...	...	...	...	...	1	115	"	115	0	0
12" ...	...	...	...	...	1	128	"	128	0	0
10" ...	...	...	...	...	1	95	"	95	0	0
9" ...	...	...	...	...	2	82	"	164	0	0
6" ...	...	...	...	...	1	50	"	50	0	0
5" ...	...	...	...	...	5	40	"	200	0	0
4" ...	...	...	...	...	12	32	"	384	0	0
3" ...	...	...	...	...	7	22	"	154	0	0
2½" ...	...	...	...	...	9	18	"	162	0	0
2" ...	...	...	...	...	10	16	"	160	0	0
								2,887	0	0
Add 10 % for freight ...	...	...	...	...	...	...	...	289	0	0
								3,176	0	0
W. I. Piping 1½" ...	...	4,100	...	...	4,100	0-6-0	ft.	1,538	0	0
" " 1" ...	...	5,000	...	...	5,000	0-4-0	"	1,250	0	0
Laying pipes.										
1½"	...	4,100	...	...	4,100	4	%	164	0	0
1"	...	5,000	...	...	5,000	4	"	200	0	0
Valves 1½"	1	...	...	...	1	40	each.	40	0	0
Hydrants	140	...	...	...	140	70	"	9,800	0	0
								1,71,234	0	0
Contingencies @ 5 % ...	...	...	...	...	...	...	...	8,561	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	179795	0	0
EXPENDITURE TO BE INCURRED IN THE 2ND YEAR.										
Suburban distribution.										
C. I. pipes.					Cwt.					
11"	55	...	...	...	307	...	...	...	...	...
9"	700	...	...	...	2,275	...	...	...	...	...
Carried over ...	...	...	...	...	2,582	...	...	...	...	...

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount Rs.	A.	P.
Brought forward ...	...	...	...	..	2,582	...	...	...	...	...
7″	765	...	...	...	2,425	...	...	...	.	...
6″	730	...	...	...	1,737	...	..	...	...	...
4″	1625	...	...	...	2,243	...	...	...	...	...
3″	545	...	...	...	578	...	...	...	...	...
2½″	230	...	...	...	220	...	...	...	...	...
2″	500	...	...	...	209	...	...	...	...	...
Add 5 % for Special ...	...	...	...	...	9,994 499	...	...	...	...	...
					10,493	7-8-0	cwt.	78,697	...	...
Add Railway freight &c. ...	...	...	...	...	...	...	...	25,00	...	...
							Rs.	81,197	0	0
Laying pipes.										
11″	...	495′	...	...	495′	14	%	69	0	0
9″	...	4,500′	..	...	4,500	12	%	540	0	0
7″	..	6,885	...	...	6,885	10	„	688	0	0
6″	...	6,570	...	...	6,570	9	„	591	0	0
4″	...	14625	...	...	14,625	6	„	878	0	0
3″	...	4,905	...	...	4,905	5	„	245	0	0
2½″	...	2,070	...	...	2,070	4	„	83	0	0
2″	...	4,500	...	...	4,500	4	„	180	0	0
								3,274	0	0
Sluice valve.										
„ 4″	1	...	...	...	1	115	each.	115	0	0
„ 9″	1	...	...	...	1	82	„	82	0	0
„ 7″	2	...	...	...	2	60	„	120	0	0
„ 6″	2	...	...	...	2	50	„	100	0	0
„ 4″	6	...	...	...	6	32	„	192	0	0
„ 3″	2	...	...	...	2	22	„	44	0	0
„ 2½″	1	...	...	...	1	18	„	18	0	0
„ 2″	1	...	...	...	1	16	„	16	0	0
Carried over ...	...	...	...	...	...	...	...	687	0	0
Carried over ...	...	...	...	...	...	...	...	84,471	0	0

Detail of Work.	No.	Measurement. L.	B.	H.	Quantity.	Rate.	Per.	Amount. Rs.	A.	P.
Brought forward ...	...	...	...	...	...	...	...	84,471	0	0
Brought forward ...	...	...	...	...	...	...	...	687	0	0
Add 10 % for freight ...	...	...	...	...	...	...	...	70	0	0
								757	0	0
Hydrants	50	...	...	...	50	70	each	3,500	0	0
								88,728	0	0
Add contingencies @ 5 %...	...	...	...	...	...	...	...	4,436	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	93,164	0	0
EXPENDITURE TO BE INCURRED IN THE 3RD YEAR.										
Nasirabad and Beawar Road Mains.										
C. I. Pipes 7" ...	690	...	...	...	cwt. 2,187	...	...	...	...	...
" 6" ...	350	...	...	...	833	...	...	...	...	...
" 4" ...	425	...	...	...	587	...	...	...	...	...
					3,607					
Add 5 % for special ...	...	...	...	...	180	...	...	...	...	...
					3,787	7-8-0	cwt.	28,402	0	0
Pipe laying.										
7" ...	...	6,210	...	...	6,210	10	%	621	0	0
6" ...	...	3,150	...	...	3,150	9	%	284	0	0
4" ...	...	3,825	...	...	3,825	6	%	320	0	0
Sluice Valves.										
7" ...	2	...	...	...	2	60	each.	120	0	0
Hydrants	25	...	...	...	25	70	...	1,750	0	0
								31,407	0	0
Add Contingencies 5 % ...	...	...	...	...	...	...	...	1,570	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	32,977	0	0
EXPENDITURE TO BE INCURRED IN 1931.										
Railway Main E 4 ...										
C. I. Pipes 9" ...	350	...	...	...	1,475	7-8-0	cwt.	11,062	0	0
Pipe laying	...	3,150	...	...	3,150	12	%	378	0	0
								11,440	0	0
Add Contingencies 5 % ...	...	...	...	...	...	...	...	572	0	0
Grand Total Rs. ...	...	...	...	...	...	...	...	12,012	0	0

APPENDIX G.

APPENDIX G.

Rainfall and Storage of the Foysagar lake.

Year.	Rainfall Inches.	Quantity stored. Unit cft.	REMARKS.
1892 ...	20·87 ...	98·46 ...	
1893 ...	32·83 ...	107·43 ...	
1894 ...	26·99 ...	9·96 ...	
1895 ...	24·43 ...	88·75 ...	
1896 ...	26·44 ...	78·06 ...	
1897 ...	23·29 ...	99·50 ...	
1898 ...	12·97 ...	28·65 ...	
1899 ...	10·10 ...	11·71 ...	
1900 ...	25·64 ...	150·00 ...	
1901 ...	15·57 ...	13·13 ...	
1902 ...	17·04 ...	44·81 ...	
1903 ...	18·28 ...	115·20 ...	
1904 ...	16·80 ...	73·87 ...	
1905 ...	7·11 ...	45·71 ...	
1906 ...	24·23 ...	90·92 ...	
1907 ...	26·17 ...	150·00 ...	

APPENDIX H.

STATEMENT OF EXPENDITURE.